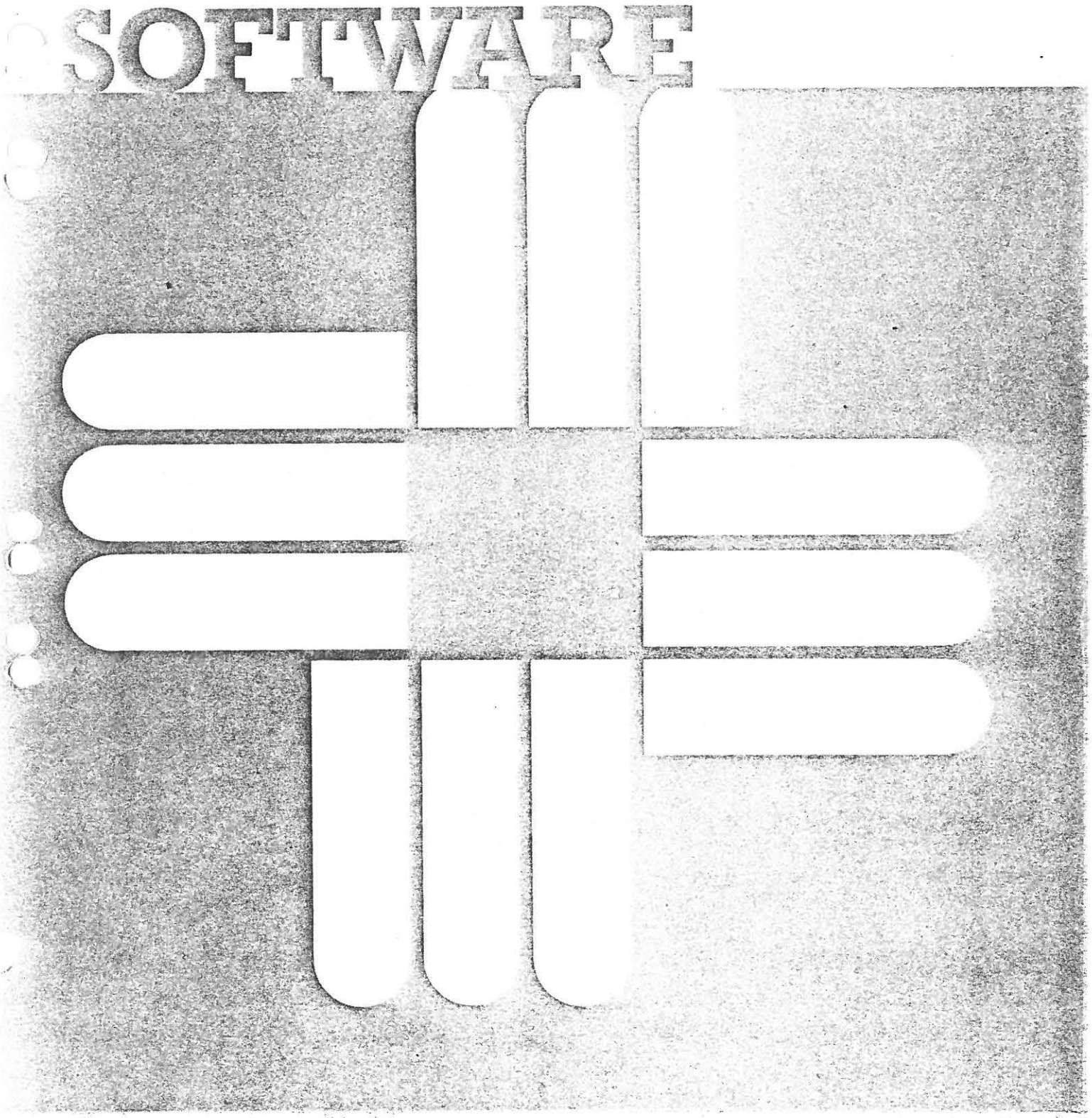
MODCOMP
MODULAR COMPUTER SYSTEMS, INC.

MAX IV System Guide

Data Storage Device Handlers



MANUAL HISTORY

Manual Order Number: 213-804007-I01

Title: MAX IV SYSTEM GUIDE, DATA STORAGE DEVICE HANDLERS

Product Number: Model 8240I

Revision Level	Date Issued	Description
H00	03/83	Initial Issue (This manual replaces chapters 8, 9, 12, 15, and 19 of the MAX IV INPUT/OUTPUT, Reference Manual, 210-610501-000 for Revision H.0 of MAX IV.
H01	11/83	Revision (H.1).
H02	07/84	Revision (H.2).
I00	09/84	Reissue (I.0).
I01	08/85	Revision (I.1). Updates to magtape handler chapter to drop 7-track support and add buffered magtape controller support.

Contents subject to change without notice.

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PREFACE

Audience

The information in this manual is directed to the applications programmer or developer with a good knowledge of MODCOMP Assembler language and familiarity with MAX IV SYSGEN and REX Services.

Subject

This manual contains information about the MAX IV Data Storage Device Handlers. The various I/O operations and modes are described. Error/Event indicators and System Generation information are provided.

Those users familiar with previous issues of MAX IV manuals may notice that the information contained in the MAX IV INPUT/OUTPUT, Reference Manual, 210-610501-000 has been reorganized to provide easier accessibility.

The information previously contained in the chapters listed below is now available as this MAX IV DATA STORAGE DEVICE HANDLERS, System Guide Manual.

Chapter 8	MAX IV FIXED AND MOVING-HEAD DISC HANDLERS
Chapter 9	MAX IV MAGNETIC TAPE HANDLER
Chapter 12	MAX IV MEMORY PLUS HANDLER
Chapter 15	MAX IV LARGE CAPACITY MOVING-HEAD DISC HANDLER
Chapter 19	MAX IV CLASSIC DISC DEVICE HANDLER

Products Supported

MAX IV Software System, Model 8240I.

Related Publications

Refer to the following manuals for additional information. Use the manual order number listed below. The most current revision level (REV) will be shipped.

Manual Order Number	Manual Title
213-804001-REV	MAX IV GENERAL OPERATING SYSTEM System Guide Manual (SGM)
213-804002-REV	MAX IV SYSGEN System Guide Manual (SGM)
213-804003-REV	MAX IV EXECUTIVE (REX) SERVICES System Guide Manual (SGM)

213-804004-REV	MAX IV OPERATOR COMMUNICATIONS System Guide Manual (SGM)
213-804005-REV	MAX IV BASIC INPUT/OUTPUT SYSTEM System Guide Manual (SGM)
213-804006-REV	MAX IV UNIT RECORD DEVICE HANDLERS System Guide Manual (SGM)
213-804008-REV	MAX IV COMMUNICATIONS HANDLERS System Guide Manual (SGM)

Special Symbols and Notations
A revision bar (|) located in the margin of the page in the text indicates a change to the manual. This change generally represents a technical change to the product due to product revision. A revision bar is also entered in the Table of Contents to flag the general location of changes in the text.

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MAX IV REVISION I.1 SUMMARY

MT.HAN

Rev I.1 of this handler includes support for the fetch extended status and read backwards features of the Buffered Magtape controller.

Support for the 7-track magtapes is not available in this revision of MT.HAN.

MAX IV REVISION I.Ø SUMMARY

MAX IV Revision I.Ø necessitated no changes to the information contained in this manual.

MAX IV REVISION H.Ø SUMMARY

TYPE Ø DISCS

Type Ø discs are those that support alternate track processing as well as dynamic determination of disc characteristics. Type Ø disc packs must be prepared by the Alternate Track Initializer Program.

When a pack is prepared for alternate track processing a number of cylinders are reserved for a spare track pool. The usable cylinders are the physical cylinders less the number of cylinders set aside for the spare track pool. The number of usable cylinders must be identified to the Operating System at SYSGEN to allow run-time compatibility. This is done with the LOGTRAN statement. The values specified for Parameter 4 on the LOGTRAN statements reflect the number of usable tracks seen by the Operating System for a logical transport. If multiple logical transports are defined for a physical transport, the total number of tracks specified in Parameter 4 (LOGTRAN statement) must equal the number of usable tracks on that physical transport.

PHYSICAL CYLINDERS - the total number of cylinders on the physical media.

USABLE CYLINDERS - the physical CYLINDERS less the number of cylinders set aside for the spare track pool.

USABLE TRACKS - the number of tracks on the disc as seen by the OS. This number is the value to be used in the LOGTRAN statement at SYSGEN. USABLE TRACKS = USABLE CYLINDERS * HEADS

UNFORMATTED CAPACITY	SECTOR/ TRACK	HEADS	USABLE CYLINDERS	PHYSICAL CYLINDERS	USABLE TRACKS	PHYSICAL TRACKS
12MB*	64	2	305	320	610	640
16MB@	64	4	200	206	800	823
24MB*	64	4	305	320	1220	1280
32MB@	64	2	808	823	1616	1646
40MB	64	5	400	411	2000	2055
80MB+	64	5	805	823	4025	4115
150MB	64	19	405	411	7695	7809
160MB*	64	10	812	823	8120	8230
300MB	64	19	809	815	15371	15485
300MB	64	19	817	823	15523	15637

* Fixed Media
\+ Fixed or Removable Media
@ Mixed Media - Fixed and Removable Media

Table S-1. CLASSIC Disc Drive Recommended Parameters for Type Ø

Table S-1 reflects that approximately 5 percent of the total disc capacity has been dedicated for alternate track allocation. This is a recommended amount. (See NOTE below.) The number of usable cylinders is determined when the pack is prepared by the Alternate Track Initializer Program.

NOTE: The total number of tracks allocated for alternate tracking must not exceed the capacity of the controller's buffer. The controller's buffer space is 120 tracks per disc transport.

The reader is referred to the following manuals:

MAX IV SYSGEN, System Guide Manual

Alternate Track Processor, Programmer's Reference Manual

MODCOMP Stand-Alone Support Software, Programmer's Reference Manual
ALTERNATE TRACK INITIALIZER

LOGICAL TRANSPORTS

MAX IV can treat the fixed and removable platters of mixed media discs as separate discs. This allows the system to believe that there is more than one disc transport per physical disc drive.

MAX IV Logical Transport Support (LTS) gives the user the ability to configure a mixed media drive as separate transports. This feature allows a combination of BIOS and File Manager support on the same physical disc transport. The reader is referred to the following manuals:

MAX IV DATA STORAGE DEVICE HANDLERS, System Guide Manual
Chapter 3 MAX IV CLASSIC DISC DEVICE HANDLER
Chapter 4 MAX IV FIXED AND MOVING-HEAD DISC HANDLERS
Chapter 5 MAX IV LARGE CAPACITY MOVING-HEAD DISC HANDLERS
Chapter 6 MAX IV BULK MEMORY HANDLER

MAX IV SYSGEN, System Guide Manual

DISCTRANSPORT SYSGEN STATEMENT

The DISCTRANSPORT SYSGEN macro is not supported in MAX IV Revision H.0. Systems that use this statement should substitute an appropriate FMTRANSPORT statement for each occurrence of the DISCTRANSPORT statement.

NOTE: The order of parameters is not the same for the two statements. The reader is referred to the MAX IV SYSGEN, System Guide Manual.

STREAMER TAPE DRIVES

MODCOMP has updated its magnetic tape controllers to support streamer tape drives. These drives allow for the continuous transferal of data without required delays for inter-record gaps.

Streamer tape support is available to the user as an option in the Extended UFT Option Word. It is the user's responsibility to access the streamer tape drive in a manner suitable for such a device.

SEVEN TRACK MAG TAPE

Seven-track mag tape drives that use 556 bpi density or even parity are not supported under MAX IV Revision H.Ø. The bits in the LDT option word that were used to support these features are ignored by Revision H.Ø. This change was necessary because of modifications made to the magnetic tape controller hardware to support streamer tape drives.

MAX IV REVISION H.1 SUMMARY

The following changes have been included in the Revision H.1 release of this manual. Additional information concerning EOM handling on magnetic tape drives has been provided. Also, information concerning the 4185 disc subsystem has been included. Table S-2 includes information pertinent to H.1.

UNFORMATTED CAPACITY	SECTOR/ TRACK	HEADS	USABLE CYLINDERS	PHYSICAL CYLINDERS	USABLE TRACKS	PHYSICAL TRACKS
.75MB	16	2	8Ø	8Ø	16Ø	16Ø
12MB*	64	2	3Ø5	32Ø	61Ø	64Ø
16MB@	64	4	2ØØ	2Ø6	8ØØ	823
24MB*	64	4	3Ø5	32Ø	122Ø	128Ø
27MB*	32	8	3ØØ	31Ø	24ØØ	248Ø
32MB@	64	2	8Ø8	823	1616	1646
4ØMB	64	5	4ØØ	411	2ØØØ	2Ø55
8ØMB+	64	5	8Ø5	823	4Ø25	4115
15ØMB	64	19	4Ø5	411	7695	78Ø9
16ØMB*	64	1Ø	812	823	812Ø	823Ø
3ØØMB	64	19	8Ø9	815	15371	15485
3ØØMB	64	19	817	823	15523	15637

* Fixed Media
\+ Fixed or Removable Media
@ Mixed Media - Fixed and Removable Media

Table S-2. CLASSIC Disc Drive Recommended Parameters for Type Ø

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CHAPTER 1
INTRODUCTION

This manual contains information about the MAX IV Input/Output handlers that support magnetic-media data storage devices. These devices include:

- Magnetic tape
- CLASSIC moving-head discs
- Fixed-head discs
- Cartridge moving-head discs
- Multi-platter moving head discs
- Floppy disc
- Large capacity moving-head discs
- Bulk memory

1.1 HANDLER'S RESPONSE

Each handler is explained in a separate chapter. Information about how the handler responds to the following I/O operations is included:

- READ
- WRITE
- REWIND
- BKFILE
- BKRECORD
- AVRECORD
- AVFILE
- WEOF
- HOME

The basic modes of data transfer are:

- Standard ASCII
- Non-Standard ASCII

- Standard Binary
- Non-Standard Binary

Differences, if any, in the handler's response to the four basic modes of data transfer are reported. A chart summarizing the handler's response to each I/O operation in each mode is presented.

After an I/O operation is performed, bits are set in the programmer's UFT status word (word #Ø) to indicate the error or event conditions that exist for the physical device to which the file is assigned. A chart indicating the meaning of each bit and the reason(s) for setting appears for each handler.

1.2 DEVICE DEPENDENT FEATURES

Device dependent options can be selected in the programmer's User File Table (UFT) when the programmer is using a particular device. These options enable/disable functions unique to certain devices. The presence of the Device-Dependent Option bit (Bit Ø) in the UFT causes some devices to perform functions not performed by all devices. The device-dependent options that apply to each handler are described in each chapter.

Many of the handlers are designed to function with several types of devices. Some of these devices have peculiar characteristics that must be distinguished by the handler. These special functions or device characteristics are identified to the handler at SYSGEN.

1.3 HANDLER SYSGEN

The SYSGEN statements necessary to include the controller(s) and device(s) in the MAX IV system are described. If special parameters are associated with devices supported by a handler, they are fully discussed in the chapter on the handler.

1.4 HOLDUP OPERATIONS

Certain situations prevent the handler from completing the operation. An example of this occurs when the physical device the handler wants to use is under exclusive use by another task. These holdup conditions are reported to the operator for resolution.

The format of the error message output to the operator is listed along with the common causes of the error.

CHAPTER 2
MAX IV MAGNETIC TAPE HANDLER (MTn)

The magnetic tape handler consists of directly connected routines for Direct Memory Processor (DMP) END-OF-BLOCK and SERVICE interrupts, utilizing hardware party-line interrupt vectors. These are permanently resident elements so that they are always available without delay. The elements are capable of controlling the transfer of data, status, and commands to/from a magnetic tape controller.

The hardware controller and handler support up to four tape transports (drives). Since these transports share the same controller and DMP, they all share the same queue, permitting only one operation at a time to be initiated. REWIND operations are an exception. Being overlapped, they allow the use of other transports while one or more transports are rewinding.

Additional controllers can be added if transports must have separate data paths and queues. A single copy of the handler will serve all transports of all controllers if each controller is assigned its own unique group/unit number.

The standard controller has the name MT (Magnetic-Tape) for system generation purposes and uses group/unit #Ø4. A DMP (#4) is required for data transmission to and from memory because of the very high data transfer rate. The data interrupt level is used as an end-of-block interrupt that occurs when the end of a block of data is detected. The logical device name for each transport is MTn, where n is the unique transport number (1, 2, ...). These device names must be assigned to the controller MT at system generation.

2.1 DYNAMIC GAPPING

The transports have a dynamic gapping capability for read/write/position operations. Therefore, transports do not slow down or stop between inter-record gaps if a new READ or POSITION operation is supplied within one-millisecond following the previous read/position operation. For a WRITE operation, two milliseconds are allowed.

If more than one transport is being accessed, this dynamic gapping capability cannot be maintained; the transports stop in each inter-record gap.

Transports alternate operations if the tasks driving them simultaneously are of the same priority. A transport being driven by a higher priority task is given all controller accesses if it can maintain enough operations in the controller's queue.

2.2 RECORD SIZE

The unit record size of a magnetic tape transport is theoretically unlimited, but is limited practically to 16,384 words (32,768 bytes), which is the largest single DMP transfer that can be initiated. MODCOMP system processors often use a 128-word record size to reduce core buffering requirements.

2.3 I/O OPERATIONS AND MODES

2.3.1 ASCII READ FROM MAGNETIC TAPE (MTn)

The ASCII READ operation causes one variable-length tape record to be spanned (gap-to-gap). If the size of the programmer's data buffer is equal to or larger than the record on tape, all the data will be contained in the buffer. If the size of the buffer supplied is smaller than the record, the remainder of the record is not stored in the buffer.

Nine-track tapes normally use an odd parity mode of read and operate at 800 bytes per inch. Phase tapes normally operate in odd parity and at 1,600 bytes per inch. Group Coded Recording (GCR) tapes operate at 6250 bytes per inch. Each tape character (less parity) is stored in an 8-bit byte in memory (2 bytes per word).

2.3.1.1 Code Conversion

Code conversions are not currently performed by the handlers because MODCOMP system processors use only ASCII and Binary codes. If the user is forced to read interchange tapes from other non-ASCII machines, the user can perform code conversion in one of four ways:

1. Convert all tapes to be read into ASCII through copy/conversion programs written by the user.

2. Convert all data buffers by table lookup directly in the user's application program after READ operations are completed.

3. Write a symbiont task to perform the desired conversions automatically whenever a particular symbiont "transport" is assigned to the user's file.

4. Modify the handler so that it performs the necessary conversion by table lookup at the service interrupt level.

2.3.1.2 EOF and EOM

If a file-mark (EOF) record is encountered during a READ operation, the EOF (end-of-file) event bit is set in the programmer's UFT. If the end-of-tape marker is sensed during the READ operation, the EOM (end-of-media) event bit is set in the UFT. If the EOF event bit is set after the end-of-tape marker has been detected, the programmer should assume that the file mark is the last record on the tape.

2.3.2 BINARY READ FROM MAGNETIC TAPE (MTn)

The Standard and Non-Standard Binary READ operations are essentially identical to the Standard ASCII READ operation. The programming context must determine if the data is ASCII (usually 7-bit codes with the most significant (eighth) bit always reset) or Binary (8-bit codes).

2.3.3 ASCII WRITE TO MAGNETIC TAPE (MTn)

The ASCII WRITE operation causes a variable-length tape record to be written that is exactly the size of the programmer's specified buffer size in memory. A maximum size record of 16,384 words (32,768 bytes) can be written, a limitation of one DMP transfer. Nine-track tapes are normally written odd parity, at 800 bytes per inch or 1,600 bytes per inch for 'phase' tapes. Each 8-bit memory byte is transmitted directly (two per word in buffer) to tape, one word at a time. Thus, only an even number of bytes can be transferred.

2.3.3.1 Code Conversion

Code conversions are not currently performed by the handlers. If the user is forced to write interchange tapes that will be read by non-ASCII machines, the user can perform code conversion in one of the following four methods:

1. Write all tapes in ASCII format and then convert these tapes to the new code with a user-coded program.

2. Convert all data buffers from ASCII to the desired code directly in the user's application program before WRITE operations are called.

3. Write a symbiont task to perform the desired conversions automatically whenever a particular symbiont "transport" is assigned to the user's file.

4. Modify the handler so that it performs the necessary conversion by table lookup and by overwriting the user's buffer before the WRITE operation is queued.

2.3.3.2 EOM

If the end-of-tape marker is detected during a WRITE operation, the EOM event bit is set in the programmer's UFT. It is good programming practice to always test EOM while writing tapes so that a file mark can be written soon thereafter.

2.3.4 BINARY WRITE TO MAGNETIC TAPE (MTn)

The Standard and Non-Standard Binary WRITE operations are essentially identical to the Standard ASCII WRITE operation. The programming context must determine if the data is in ASCII or Binary. For Standard Binary, bytes Ø, 2, and 3 should be set in the programmer's buffer in a manner required by this format.

2.3.5 FILE/RECORD OPERATIONS

2.3.5.1 REWIND to Magnetic Tape (MTn)

The REWIND operation causes the transport to be commanded to rewind if it is not already at the load point (BOM). This operation appears to be completed (EOF and BOM set) as soon as the REWIND is started, but all subsequent operations to the rewinding transport are held back from the controller's queue until the actual rewind complete signal appears at the load point (BOM). This frees the controller for other operations to other transports during the indefinite rewind period. As soon as a REWIND is completed, any task trying to queue other operations is then allowed to continue with the queuing of that operation.

If the Device-Dependent Option Bit (Bit 1) in the UFT is set when a REWIND operation is requested, the transport is thrown into a hardware offline state as soon as the REWIND is started. In this case, manual operator intervention is necessary before other operations to the transport can take place.

2.3.5.2 HOME to Magnetic Tape (MTn)

The HOME operation is a null operation. The magnetic tape transport is not affected by the operation. This operation sets the EOF and EOM event bits in the UFT status word.

2.3.5.3 BACKSPACE FILE to Magnetic Tape (MTn)

The BACKSPACE FILE operation causes the tape to be moved backward, a record at a time, until a file-mark record is detected or until the tape load point (BOM) is found. If BOM and EOF are both set at the end of the operation, the tape was already at the load pointer or it skipped records in which no file mark was found to reach load point. If only EOF is set, one or more records were skipped and the tape is stopped in front of the last skipped record that must have been a file-mark record.

The hardware operation performed for backspacing files is actually a backspace record operation. Thus, a service interrupt occurs after each record termination gap is detected. If the original BKFILE operation node is still the highest priority task operation in the controller's queue, and if the EOF and BOM status has not yet been detected by the handler, the next hardware backspace record command is issued. If a new operation to this or to another transport has been queued by a higher priority task, the operation node for the BKFILE operation is requeued appropriately and the higher priority operation can use the controller.

BKFILE operations usually continue without the tape stopping in the gap between intermediate records if no higher priority operations are queued.

2.3.5.4 BACKSPACE RECORD to Magnetic Tape (MTn)

The BACKSPACE RECORD operation causes the tape to move backward over one tape record if the transport is not already in the load point gap. If the BOM and EOF event bits are both set in the UFT at the completion of the operation, no record was skipped and the transport was, and still is, in the load point gap. If only the EOF event bit is set, the record skipped was a file mark. If no event bits are set, a data record was skipped.

2.3.5.5 ADVANCE RECORD to Magnetic Tape (MTn)

The ADVANCE RECORD operation causes the transport to skip over one tape record in the forward direction. The EOM event bit is set in the programmer's UFT status word if the skipped record contains the end-of-tape marker.

If the ADVANCE RECORD operation is requested after the end-of-tape marker is passed, the programmer risks finding no record and the tape transport may go offline and unload because the tape supply has been exhausted. If the EOF event bit is set after the operation and after the end-of-tape marker has been detected, the programmer should assume that the file mark is the last record on the tape. It is good programming practice to always test EOM while writing tapes so that a file mark can be written soon thereafter.

2.3.5.6 ADVANCE FILE to Magnetic Tape (MTn)

The ADVANCE FILE operation causes ADVANCE RECORD operations to be performed until a file-mark record (EOF) is detected. A service interrupt occurs at the end of each record so that the handler can determine if the operation node must be moved back in the queue to allow higher priority controller operations to precede it or if it should continue advancing records. In the latter case, the transport usually continues advancing without the delay of stopping the transport in the inter-record gaps. If the end-of-tape marker (EOM) is detected before a file mark record (EOF) the advance file operation is stopped at EOM. The EOM event bit is set in the UFT status. If a file mark is not written at or after the EOM marker, the programmer risks having the transport unload and go offline.

2.3.5.7 WEOF to Magnetic Tape (MTn)

The WEOF operation writes a file-mark record as defined by the transport hardware. This record can then always be detected during READ, ADVANCE, and BACKSPACE operations and can be used by the programmer for signaling purposes.

It is good programming practice to always write a file mark after any group of records to be treated as a group entity for subsequent processing. It is also good practice to write a file mark at end-of-tape (EOM). A device-independent practice would be to test for the end-of-tape marker (EOM) after every WRITE operation and to BACKSPACE and then write a file mark when this condition is detected. This works for discs, which give an EOM indication immediately after the last sector of the last track of the partition is accessed, as well as, for magnetic tapes. The data record that was backspaced can be held for rewrite on the substituted device or reloaded transport if writing is to continue. Magnetic tapes can have several records written after EOM is detected; thus, the backspacing operation is not necessary if device independence is not a programming factor.

Some programmers find it convenient to write two or more contiguous file marks on the transport when the end of useful tape information ends before the end of the tape is detected. Cooperating programs that read the data can use this signal to avoid processing any further data on the tape as they would if EOF and EOM conditions are simultaneous.

2.3.5.8 Summary Tables

Mag Tape Handler Summary tables appear at the end of this chapter. Table 2-1 contains information about the handler's response to I/O operations in the four modes of data transfer. Table 2-2 lists the error and event bits in the UFT status word (UFTSTA). Conditions causing the error or event are also listed.

2.4 UFT OPTIONS

The user indicates the data format mode and various options selected by setting bits in the UFT option word and the extended UFT option word.

2.4.1 DEVICE-DEPENDENT OPTIONS

The Device-Dependent option is selected by setting Bit 1 (DDO) of the UFT option word. The presence of this bit causes some devices to perform functions not performed by all devices. Successful use of this feature requires that the user's logical file be assigned to a particular device with the ability to respond as expected to the DDO.

The Magnetic Tape (MT.HAN) handler responds to the device dependent option in the following manner. When Bit 1 is set during a WRITE operation, a section of magnetic tape is erased before the normal WRITE operation is initiated. This can be used by programs that choose to write a magnetic tape without the System Recovery (SR) Option specified. When a WRITE attempt fails in a section of tape, the WRITE may be repeated at a new position of the tape surface. This is normally performed automatically if the System Recovery (SR) Option is specified.

During a REWIND Command to magnetic tape, Bit 1 specifies that the device transport should be put offline after initiating the REWIND. Thus, after such a REWIND, no program can access the transport without operator intervention.

2.4.2 STREAMER MODE

The user has the ability to place a streamer tape drive into streamer mode by setting the Streamer (STM) Option. The STM option is selected by setting Bit 9 of the extended UFT option word (XUFOPT).

If STM is reset during any of the I/O REX services, or a REX REWIND or REX TERMINATE is issued, then the tape drive returns to the normal start-stop mode of operation. The I/O REX services that support Streamer mode on magnetic tape devices are:

READ
WRITE
WRITE END-OF-FILE
ADVANCE RECORD
ADVANCE FILE
BACKSPACE RECORD
BACKSPACE FILE

2.4.3 BUFFERED MAGNETIC TAPE SUBSYSTEM FEATURES

Streamer mode (STM, bit 9) is supported for all streamer tape drives including drives on the magnetic tape controller. Density selection is controlled by the hardware switches on the magtape drive and is not selectable with the handler.

During a read operation to a buffered magtape two device dependent features can be selected. These are a backwards read capability and fetch extended status. Figure 2-1 shows the extended UFT option word used to select these features.

Bit 12 (RDB) in the extended UFT option word, XUFOPT, selects the backwards read. The user provides the buffer address and byte count for the record. Data is stored in the buffer in the correct order. A backward read will only be executed if the FEX bit (bit 13) is reset.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
									STM			RDB	FEX	START	

Bit 9 - STM - Places a streamer tape drive into streamer mode.
Bit 12 - RDB - Read backwords. (FEX, bit 13 must be reset.)
Bit 13 - FEX - Fetch extended status.
Bit 14, 15 - Start of transfer bits for extended status FEX.

Figure 2-1. Extended UFT Option Word, XUFOPT

The fetch extended status option takes precedence over read backwards. Bit 13 (FEX) in the extended UFT option word, XUFOPT, selects the fetch extended status function. The user provides the buffer address for the extended status data and the byte count for the transfer. The maximum byte count for a FEX read is 48 bytes. Bits 14 and 15 in XUFOPT determine the start of transfer for the FEX. The start of transfer bits are defined in Table 2-1 below. Setting bits 14 and 15 in XUFOPT creates an illegal start of transfer address for a FEX. Error bit 7, ILL, is set in the UFT status to indicate this condition. Bit 6, FXER, in the UFT status indicates that the extended status contains error information.

Bits	Description	Start at Word	Word Count
Ø Ø	Controller status word	Word Ø	24
Ø 1	Unit Ø's extended status	Word 4	2Ø
1 Ø	Currently selected unit's ID		
	Unit Ø	Word 8	16
	Unit 1	Word 12	12
	Unit 2	Word 16	8
	Unit 3	Word 2Ø	4
1 1	Illegal		

Table 2-1. Start of Transfer Bits

2.5 ERROR PROCEDURES

2.5.1 SYSTEM RECOVERY

If the programmer addresses a transport with bit SR of the UFT option word set, automatic error recovery is attempted. If the following errors occur during READ or WRITE operations, the operation is retried up to eight times.

- Data rate overflow/underflow
- Parity and/or CRC errors
- DMP memory parity

The bad records are backspaced before each retry. WRITE operations try each new WRITE with a 4-inch gap skip so that the new attempt is made on a new media position. If the operation is still no successful after eight tries, the handler "gives up" and puts the transport offline, thus causing the X Task to inform the operator of the unrecoverable condition. The transport stays offline, with all subsequent operations being diverted to the transport's slough queue, until the operator makes a decision. This decision may be:

- To try again (up to eight more times)
- To let the program proceed as if the operation were successful, or
- To abort the tasks using the transport.

If the following errors occur, the handler does not attempt eight retries but immediately informs the operator (if bit SR of the UFT option word is set):

- Device is inoperable (example, power off)
- Device media failure (character in gap)
- DMP failure to transmit any data
- Watchdog timer expires after last initiated operation (optional)

A message reporting a holdup condition is output to the operator in the following format:

```
!MTn?/tttttt/oooooo
```

tttttt - is the calling task's name.

oooooo - is the current task overlay name.

This message reports the following conditions:

- Device does not exist
- Device under exclusive use by another task
- Device already offline

2.5.2 USER ERROR RECOVERY

If the programmer did not set bit SR of the UFT option word, no error recovery is attempted (unless RNQ is set), but the programmer is immediately informed of the error condition by appropriate error bits being set in the UFT. The programmer must then institute retry or device substitution operations.

2.5.3 LOK ABORT

If a WRITE attempt to a file-protected transport occurs, it is treated as a programmer error rather than a device error and the calling task is aborted with the reason code LOK.

2.5.4 EVENT LOGGING

The System Event Logging routines are called whenever tape problems are encountered and resolved by the handler. This is done so that degradation of system performance caused by tape problems does not go by unnoticed. Problems that are not resolved by the handler are reported and logged by other system routines.

On completion of an unsuccessful operation, the handler fetches and saves primary status. It then updates a retry counter and either gives up if the counter is exhausted or retries the operation. On completion of a successful operation, the retry counter is checked, and if retries are indicated, the event logging routines are called. Various parameters are passed to these routines including one comprised of bits from the saved error status. A detailed description of the I/O Retry node format is contained in the EVENT LOGGING chapter of the MAX IV GENERAL OPERATING SYSTEM, System Guide Manual.

2.6 SYSTEM GENERATION

The following statements are required in a system generation source file if this device is to be included in a system. Detailed descriptions of these statements and the rules of order are included in the MAX IV SYSGEN, System Guide Manual. Parameter 4 of the DEVICE statement defaults to Bit 14 set, #0002.

```
CONTROLLER          MT,4,4,TIMED
     .
     .
     .
DEVICE              MT1,MT
DEVICE              MT2,MT
DEVICE              MT3,MT
DEVICE              MT4,MT
```

Parameter 4 of the DEVICE statement is used to indicate a buffered magtape drive. Bit 7 set in the LDT characteristics word (parameter 4) indicates a buffered magtape controller. Bit 14 is set for all magtape drives. Bit 14 is defaulted in the example above. For example:

```
DEVICE              MT1,MT,,#102  Buffered magtape
DEVICE              MT2,MT,,#102  Buffered magtape
DEVICE              MT3,MT,,#102  Buffered magtape
DEVICE              MT4,MT,,#102  Buffered magtape
```

MAGNETIC TAPE TRANSPORTS (MTn) RECORD SIZE ≤ 32768 BYTES

	ASCII MODES		BINARY MODES	
	STANDARD	NON-STANDARD	STANDARD	NON-STANDARD
0 READ	INPUT ONE TAPE RECORD (STOP TRANSMISSION SHORT OF BUFFER SIZE IF GAP DETECTED)	<-----SAME (EXCEPT DATA IS PACKED IN INTERCHANGE 6 BIT --> 8 BIT FOR 7TK)	<-----SAME AS STANDARD ASCII	<-----SAME AS STANDARD ASCII
1 WRITE	OUTPUT ONE TAPE RECORD (EQUAL TO SIZE OF USER'S BUFFER)	<-----SAME (EXCEPT DATA IS UNPACKED IN INTERCHANGE MODE 8 BIT -->6 BIT FOR 7TK)	<-----SAME AS STANDARD ASCII	<-----SAME AS STANDARD ASCII
2 REWIND	START REWIND OF TAPE TO LOAD POINT (BOM). OPERATION APPEARS COMPLETED. SUBSEQUENT OPERATIONS ARE HELD BACK AUTOMATICALLY. +	<-----SAME	<-----SAME	<-----SAME
3 BKFILE	SKIP TAPE RECORDS IN REVERSE DIRECTION TILL FILE MARK RECORD DETECTED (OR LOAD POINT)	<-----SAME	<-----SAME	<-----SAME
4 BKRECORD	SKIP ONE TAPE RECORD IN REVERSE DIRECTION IF NOT AT LOAD POINT	<-----SAME	<-----SAME	<-----SAME
5 AVRECORD	SKIP ONE TAPE RECORD IN FORWARD DIRECTION	<-----SAME	<-----SAME	<-----SAME
6 AVFILE	SKIP TAPE RECORDS IN FORWARD DIRECTION TILL FILE MARK RECORD DETECTED	<-----SAME	<-----SAME	<-----SAME
7 WEOF	WRITE FILE MARK RECORD (HARDWARE)	<-----SAME	<-----SAME	<-----SAME
8 HOME	null +	<-----SAME	<-----SAME	<-----SAME

+ This operation sets EOF and BOM event bits in UFT status word.

Table 2-2. Magnetic Tape Operations and Modes

PROGRAMMER'S ERROR BIT IN UFTSTA	OPERATOR'S REASON CODE	REASON FOR ERROR IF SET
0	ER	SOME ERROR EXITS
1	OVF OVERFLOW/ UNDERFLOW	-OVERFLOW/UNDERFLOW- HIGHER PRIORITY DMP IS USING TOO MUCH CPU TIME. THIS ERROR IS NOT REPORTED TILL AFTER EIGHT (8) RETRY ATTEMPTS IF SYSTEM RECOVERY MODE SPECIFIED.
2	PAR PARITY OR DATA CHECK	-LONGITUDINAL OR TRANSVERSE PARITY ERROR HAS OCCURRED DURING LAST READ OR WRITE. -CRC ERROR HAS OCCURRED (9-TRACK ONLY). THESE ERRORS ARE NOT REPORTED TILL AFTER EIGHT (8) RETRY ATTEMPTS IF SYSTEM RECOVERY MODE IS SPECIFIED.
3	INO INOPERABLE	-DEVICE DOES NOT EXIST -DEVICE INOPERABLE (TRANSPORT POWER OFF OR UNLOADED). -WATCHDOG TIMER HAS EXPIRED ~ 2.5 SEC. AFTER OPERATION WAS INITIATED.
4	MPE MEMORY PARITY	-A MEMORY PARITY ERROR DETECTED WHILE DMP WAS TRANSMITTING DATA TO/FROM MEMORY.
5	LOK WRITE LOCK	-A WRITE WAS ATTEMPTED TO A FILE-PROTECTED TRANPORT.
6	CIG CHARACTER IN GAP	-CHARACTERS DETECTED IN INTER-RECORD GAP. -DISCONTINUITY IN TAPE SURFACE.
7	ILL	-ILLEGAL START OF TRANSFER ADDRESS
8	HOL HOLD	-DMP DID NOT ADVANCE (HARDWARE FAILURE).
PROGRAMMER'S EVENT BIT IN UFTSTA	**REASON CODE**	**REASON FOR EVENT IF SET**
9	EOM END-OF- MEDIUM	-SET IF OPERATION IS COMPLETED IN VICINITY OF END-OF-TAPE MARK, NORMALLY TESTED AFTER WRITE OPERATIONS.
10	EOF END-OF- FILE	-SET IF A FILE MARK RECORD IS ACCESSED DURING READ, ADVANCE OR BACKSPACE OPERATION -SET AFTER WEOF, REWIND, OR null OPERATIONS.
11	BOM BEGINNING- OF-MEDIUM	-SET AFTER null OR REWIND OPERATIONS. -TRANSPORT IS AT LOAD POINT AFTER REWIND OR BACKSPACE OPERATION.

Table 2-3. Magnetic Tape Errors and Events

CHAPTER 3
MAX IV CLASSIC DISC DEVICE HANDLER (LXn)

The CLASSIC Disc Controller is a high performance disc subsystem consisting of a controller and from one to four disc drives. It embodies a set of features that classify it as an 'extended' controller. The extended features supported by the handler are described in this chapter. The disc drives supported are of the types known as '3330' and 'Winchester' generic types and consist of both fixed and removable media with capacities ranging from 12 to 300 megabytes.

This handler was developed after and is a different handler from the MAX IV Fixed- and Moving-Head and MAX IV Large Capacity Moving-Head Disc handlers. Its basic structure (the three levels of execution) is the same as other MAX IV handlers.

The System Generation (SYSGEN) requirements, for the most part, are the same as other disc devices except where additional options are available. SYSGEN procedures are further documented later in this chapter. The standard controller names for SYSGEN purposes and their standard device and DMP addresses are given in the description of the SYSGEN statements.

This handler consists of the directly connected DATA and SERVICE interrupt routines and a TASK level routine. The DATA interrupt is used for Direct Memory Processor (DMP) End-of-Block detection. The DATA and SERVICE interrupts use unique hardware party-line interrupt vectors. These are permanent resident elements so that they are always available without delay. The elements are capable of controlling the transfer of data, status, and commands to/from the CLASSIC Disc controller.

The hardware controller and handler support up to four transports (drives). Since these drives share the same controller channel and DMP number, they all share the same queue, permitting only one operation at a time to be initiated. All operations after the first are examined to see if they access other physical units. If so, seeks known as "overlapped seeks" are attempted on those units.

Additional controllers can be added if drives must have separate data paths and queues. A single copy of the handler serves all drives of all controllers if each controller is assigned its own unique DMP number.

To effectively use the very high data transfer rate at which this controller can operate, the handler is written to use only DMP transfer mode. The data interrupt level is used as an End-of-Block interrupt that occurs when the DMP finishes transmitting a block of data.

3.1 DISC PARTITIONS

Each physical transport may be partitioned into one or more logical transports and each logical transport may be partitioned into many logical devices. Each logical device has its own independent addressing mode and error control. Most partitions can be made to simulate the sequential operation of a unit record magnetic tape when addressed by the programmer. However, these partitions can be addressed in a random access manner if the programmer chooses. Some partitions can be addressed in a random manner with indefinite unit record (sector) sizes. The naming conventions for logical disc partitions are described in the MAX IV BASIC I/O SYSTEM, System Guide Manual.

The assignment of partitions on a disc with moving heads is more complicated than on fixed-head discs, since the most frequently used partitions need to be assigned to the same or adjacent cylinders (usually near the center of the disc) if head movement is to be minimized. On a disc with both fixed and moving heads, the most frequently used partitions should be assigned in the fixed-head area.

Each disc partition has its own entry in the logical device list. Each partition also has its own unit record definition (words per sector or unlimited sector size) and its own addressing geometry. Partitions can even overlap the same disc media space assigned to other partitions, giving the same disc area more than one set of rules that can be chosen by simply assigning the programmer's file to the appropriate partition.

3.2 HANDLER ADDRESSABILITY

A standard large capacity moving-head disc has some combination of the following limits:

number of cylinders: 320, 411, 815, 823, or 1626
number of addressable heads: 1, 2, 4, 5, 10, or 19
number of sectors per track: 42 or 64

However, both the controller and the handler also support nonstandard discs having from 1 to 2048 cylinders, from 1 to 64 heads, and from 1 to 64 sectors per track.

3.3 WRITE PROTECT

The controller provides the ability for the operator to protect a portion or all of the disc on unit 0 and all of each of the other discs in the system. A panel of eight switches is mounted on the front edge of the controller PC assembly; seven of these switches are used to set the number of the highest cylinder (starting from 0) to be protected. The eighth switch enables or disables the other seven.

In addition to this write lockout panel, each unit has a 'Read Only' switch on its front panel; this switch will protect the entire disc when activated (unit Ø's switch overrides the controller's lockout panel). Changes in the position of this switch are ignored while a unit is selected; deselection enables recognition of its new condition.

3.4 TRACK BUFFER

The CLASSIC Disc Controller employs a full track buffer internal to the hardware. On an initial READ operation from a disc track, the entire track is read into this buffer while the specified sector(s) are being transferred into memory. Data for subsequent READ operations from the same track are transferred directly from this buffer without a disc access. WRITE operations do not use this scheme and are performed on a sector-by-sector basis. Use of this buffer eliminates the possibility of under or overflow and allows the controller to transfer data at any rate up to the maximum rate of the I/O bus.

3.5 GEOMETRY

For a variety of reasons, most notably timing, it is impossible to perform two or more WRITE operations to sequential sectors of a track in a single revolution of the disc. This is no problem for READ operations because of the RAM buffer. To alleviate the problem for writes, addressing geometry, which is a software controlled feature, can be used. This feature permits the sector number (unit record number) used by the programmer to be different from the hardware sector number chosen by the handler. It is useful when programs are using the disc as a general purpose sequential device and it is desired to maximize the number of sectors that can be accessed within a physical revolution of the disc.

Let us assume a geometry of 2 is SYSGENed as an example. As the program addresses sequential sectors, it is actually addressing only the even sector numbers on the first revolution and odd sectors on the next revolution. The program can access all of a track without losing additional revolutions for each sector access.

As the average amount of time spent processing the records between sequential accesses goes up, a point is reached that again causes the loss of a revolution for each sector. If the program falls into this class, it will more efficiently address a partition if the geometry is greater. Although it takes more revolutions to address an entire track, it is much faster than missing every revolution. A geometry specification can have any value subject to the following restrictions:

- May range from 1 to the number of sectors per track minus two without exceeding 32.
- May not be a factor or multiple of a factor of the number of sectors per track minus one.

Direct hardware geometry (1) may be useful when a special application program must address the disc in blocks larger than a

sector. The partition record size must be specified as Ø (unlimited). In this case, the concept of a sector must still be used to address the start of a record, but a record can be up to 16,384 words in length. An optional hardware detectable End-of-Record (EOR) mark may be written in the last sector of such multi-sector records to facilitate automatic termination during READ operations. When this type of partition is defined, the programmer must compute the start of the multi-sector records by keeping in mind the actual sector boundaries.

3.6 DUAL PORT OPTION

This CLASSIC Disc Controller provides a dual port option, a feature whereby two computers may gain access to the same device on a first-in-first-out basis. Any one or all of the units on a controller may be dual ported.

For normal operation, the CLASSIC Disc Device handler supports this option as a transparent feature. However, some applications require the ability to exert control over a dual ported device in a device-dependent environment. This requires the use of an inter-processor EXCLUSIVE USE service that is dependent upon the provision of a generalized processor-to-processor communication system service and whatever additional hardware is required by the system service. Therefore, there will be no inter-processor exclusive use service with this handler.

3.7 OPERATING ENVIRONMENT

The handler can be included in a MAX IV Operating System by using standard SYSGEN methods. Any MODCOMP CLASSIC computer system with sufficient resources to run a MAX IV System supports this handler. A minimum configuration would consist of a CLASSIC 78xy Central Processing Unit (CPU) with 128K bytes of memory, a console terminal device, and a CLASSIC Disc Controller with one disc drive.

3.8 RESPONSES TO OPERATIONS AND MODES

The following operation descriptions refer to non-data-chained sector-sized unit records, except as noted. For further information about data chaining, refer to the MAX IV BASIC I/O SYSTEM, System Guide Manual.

All four modes of operation, that is, Standard ASCII, Non-Standard ASCII, Standard Binary, and Non-Standard Binary are identical in this handler.

3.8.1 FPI ABORT

Any READ, WRITE, WEOF, ADVANCE RECORD, or ADVANCE FILE operation that attempts to access a sector beyond the end of the partition causes the calling task to be aborted with a reason code of FPI and a WHAT code of the logical file name. FPI stands for File Position Index.

3.8.2 EOM

Any READ, WRITE, WEOF, ADVANCE RECORD, or ADVANCE FILE operation to the last sector of a partition causes the EOM event bit to be set.

3.8.3 READ FROM DISC PARTITION

The READ operation causes one sector to be read into the program buffer. If the size of the buffer specified by the program is equal to or smaller than a sector, the transfer is terminated at the specified word count (even number of bytes). If the size of the buffer is larger than a sector, only a sector is transmitted. If the program is written in a device-independent manner but tries to adjust to device record size, the program can call the I/O INFORMATION service to find the sector size and adjust the program logic accordingly.

3.8.3.1 Unlimited Record Size

If the partition has been specified to have an unlimited record size, a buffer size of up to 16,384 words (limit of one DMP transfer) can be specified with one READ operation. However, if a sector is encountered in the range of the READ that has an End-of-Record (EOR) mark, the DMP transfer and disc READ operation terminate automatically at the end of this marked sector.

3.8.3.2 File Position Index

The sector (starting sector for unlimited record size partitions) that is accessed during a READ operation is determined by the RANdom flag, Bit 5 in the UFT option word.

If the RAN flag is reset, a sequential access method is assumed and the current File Position Index (FPI) that is maintained in the File Assign Table (FAT) entry is used as the logical sector number. This number is converted by the handler to a physical sector number that is appropriate for the partition's defined geometry. When the READ operation is successfully completed, the FPI value is incremented so that the next operation to this file will be to the next logical sector. This incremented value is then moved to the program's User File Table (UFT).

If the RAN flag is set, the FPI in the program's UFT is used directly as the desired logical sector number. Again, this is converted to the actual physical sector by the handler's geometry algorithm. When the READ operation is successfully completed, the FPI in the UFT is incremented. It can be easily seen that if the program never modifies the FPI in the UFT after initially setting it, sequential operation occurs thereafter by default, even in the Random access mode. It should also be obvious that since addressing of a partition is maintained at the UFT or file level, the program may keep many unique sequential pointers within the same disc partition by assigning the partition to a different file name for each independent index desired.

For partitions with unlimited record size, the sequential index system is useless, particularly in a Sequential mode, because it always points to the next logical sector. When such partitions are being used with records larger than a sector, the next sequential record may be accessed by the programmer manually incrementing the UFT's FPI by an amount equal to the number of hardware sectors contained in each record. Only the Random access mode and a geometry of 1 are convenient for such usage.

3.8.3.3 NULL Word

Since this device is a DMP device, the NUL markers (two NUL bytes on a word boundary) that can mark the end of useful information in the buffer are not interpreted by the WRITE command. However, since this marker is written on disc, a READ operation causes it to again appear in the READ buffer as data. This allows any syntax analysis routines that depend on it to find it in the normal place at the end of useful information.

If a sector was originally written with a WEOF operation, the EOF event bit in the program's UFT is set when the sector is read. The programmer's buffer also has the ASCII value '$$' stored in bytes Ø and 1 and two NUL bytes stored in bytes 2 and 3.

3.8.4 WRITE TO DISC PARTITION

The WRITE operation causes one sector to be written to the disc. If the size of the programmer's buffer is equal to or less than the partition's sector size in words (even number of bytes), the exact number of words specified is transmitted and the remainder, if any, of the sector is zero filled. If the buffer is larger than a sector, only a sector is written and the remainder of the data in the program's buffer is ignored.

If the partition has been specified to have an unlimited record size, a buffer size of up to 16,384 words (limit of one DMP transfer) can be specified with one WRITE operation. An EOR mark is automatically written in the last sector that falls within the write range if this feature has been SYSGENed for the partition or optioned in the UFT (Bit 7 of Extended UFT Option Word (XUFOPT)). This flag causes a multi-sector READ operation to terminate short of its specified buffer size if this sector is encountered before the specified block size is satisfied.

The sector (starting sector for unlimited record size partition) to be accessed during the WRITE operation is determined in exactly the same manner as in the READ operation.

3.8.5 REWIND AND HOME TO DISC PARTITION

The REWIND and HOME operations do not transmit any data to the disc, but the disc partition must not be offline when the operations are specified. The HOME operation is a null operation. The REWIND operation resets the File Position Index to Ø in the programm's UFT and in the File Assign List Entry. Both operations set the EOF and BOM event bits in the UFT status word.

One of these operations is appropriate at the beginning of a program when device-independent conventions are being followed by the programmer. HOME must be used instead of REWIND when the position of the FPI (next addressable sector) is not to be changed.

3.8.6 BACKSPACE RECORD TO DISC PARTITION

The BACKSPACE RECORD (BKRECORD) operation decrements by one the FPI (in File Assign List Entry if sequential, in UFT if random) and then reads the indicated logical sector. The physical sector is computed by the same algorithm used for the READ operations. A two-byte system internal buffer is used for this operation so that the programmer does not have to set aside a buffer. When the READ operation is complete, the FPI is set to the sector just read, so that this is the next sector accessed on the next forward operation.

If the accessed sector was a file-mark record ($$), the EOF bit is set in the programmer's UFT. Backspacing a disc sequentially is often convenient when device-independence is the programmer's goal. If backspacing beyond sector Ø is attempted, no operation occurs and the EOF and BOM event bits are set in the UFT.

3.8.7 BACKSPACE FILE TO DISC PARTITION

The BACKSPACE FILE (BKFILE) operation is similar to BKRECORD except that the process continues until a file-mark record or Beginning-of-Media (BOM) (sector Ø) is found. The operation node is dequeued at the start of each track and then requeued so that higher priority operations on the disc controller can take precedence over its completion.

3.8.8 ADVANCE RECORD TO DISC PARTITION

The ADVANCE RECORD (AVRECORD) operation is similar to BKRECORD except that the FPI is incremented by one. The operation is as fast as a READ operation, and it sets the EOF event bit in the programmer's UFT if a file-mark record is encountered. If the last sector of the partition is encountered, the EOM event bit is also set.

3.8.9 ADVANCE FILE TO DISC PARTITION

The ADVANCE FILE (AVFILE) operation is similar to AVRECORD except that the process continues until a file-mark record is found or the operation tries to read beyond the partition end. The operation node is dequeued at the end of each track and then requeued so that higher priority operations on the controller can take precedence over its completion. The EOF event bit is set upon completion of the successful operation.

3.8.10 WEOF TO DISC PARTITION

The WRITE END-OF-FILE (WEOF) operation causes the next sector, as specified by the current FPI, to be written with the EOF hardware flag set in the sector. A two-byte buffer containing the bytes '$$' is written and the remainder of the sector is filled with all zero data. The FPI is incremented by one at the successful completion of the operation. This operation is similar to WRITE except for the data transmitted.

3.8.11 SUMMARY TABLES

CLASSIC Disc Handler summary tables appear at the end of this chapter. Table 3-3 contains information about the handler's response to I/O operations in the four modes of data transfer. Table 3-4 lists the error and event bits in the UFT status word (UFTSTA). Conditions causing the error or event are also listed.

3.9 TYPE Ø DISC SUPPORT

With Revision H.Ø of MAX IV, the CLASSIC Disc Device Handler has been upgraded to support Type Ø disc devices. Type Ø disc devices are those that support alternate track processing as well as dynamic determination of the discs' characteristics. This indicates that any disc supported by the CLASSIC Disc Device Handler can be run as Type Ø as long as it has previously been initialized using the Alternate Track Initializer, a stand-alone processor. Refer to the MODCOMP Stand-Alone Support Software, Programmer's Reference Manual.

SYSGENing a Type Ø disc transport is similar to SYSGENing any other type disc transport for the CLASSIC Disc Device Handler. Naturally, the 'disc type' parameter of the FMTRANSPORT and/or the DISCCHARACTER statement must be Ø (zero). Also, if the disc device to be used does not have 64 sectors per track, then parameter 4 of the DISCCHARACTER statement must indicate the number of sectors per track for the disc configured.

NOTE: Initializing a disc with a MODCOMP alternate track map and then using it as a non-zero type disc will produce unpredictable results.

Due to the nature of Type Ø disc support, it cannot be determined at SYSGEN or when assemblying transient partition definitions if a partition or logical transport definition falls within the legal bounds of the physical device. Therefore, it is possible to create logical transports and partitions that run off the end of the physical device. Any attempt to access such partitions will cause an STC abort if system error recovery is utilized. The STC abort indicates that a device positioning request has been made to a Sector, Track, or Cylinder beyond the physical limits of the transport. Any logical transports defined in this way will cause the 'INVALID LOGICAL TRANSPORT XXX' error message to appear at the operators' console.

NOTE: The model 4185 disc subsystem requires a longer watchdog timer. Therefore, during system startup the O/S checks the controller ID and changes the watchdog timer value if necessary.

3.10 UFT OPTIONS

There are several features available as options--some of which are general to discs and others specific to this type of disc controller. Most of the options are specified in the UFT at execution time either by the Device Dependent Option (DDO) bit (Bit 1 of UFTOPT) or by bits in the Device Dependent Option field of XUFOPT. Figure 3-1 shows the Extended UFT Option Word XUFOPT.

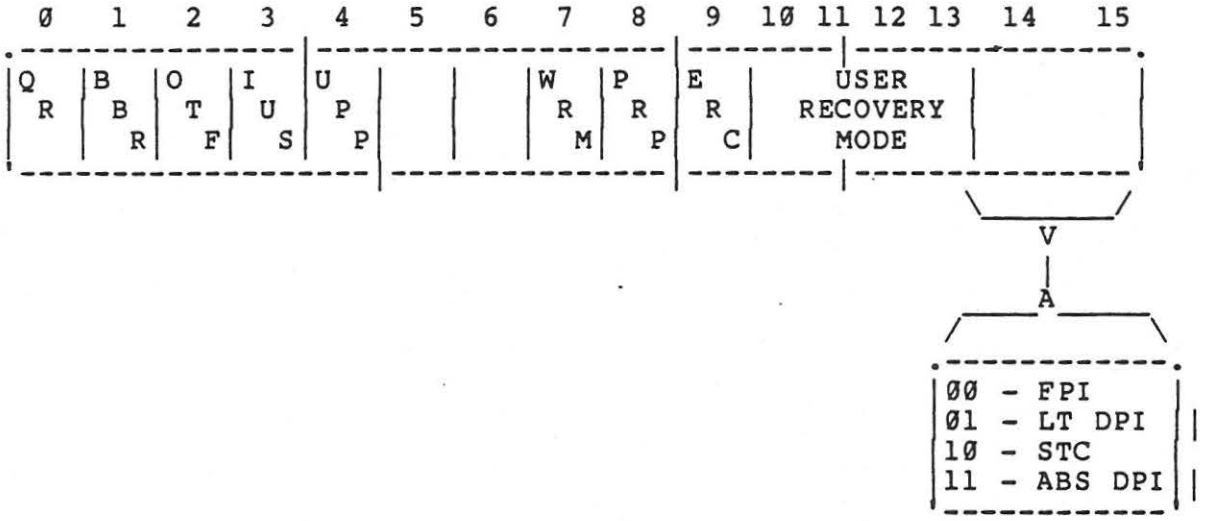

Figure 3-1. Extended UFT Option Word (XUFOPT)

The first seven options (Bit 0 through 6) are available throughout the MAX IV I/O system. Refer to a description of these options in the MAX IV BASIC I/O SYSTEM, System Guide Manual.

3.10.1 WRITE RECORD MARK - BIT 7 - WRM

A WRITE or WEOF operation to a partition does not cause an End-of-Record (EOR) mark to be added to the last sector of the record unless either the DISCDEVICE SYSGEN statement specifies its unconditional addition or this bit is set in the UFT (XUFOPT). Once an EOR mark has been written, a READ operation on that record cannot progress beyond the sector containing the EOR. These marks are generally used only when a partition has an unlimited record size and the programmer wishes to use the EOR detection capability to delimit the records. To indicate detection of an EOR on a READ, the BOM bit in the UFT status word is set.

3.10.2 PREP - BIT 8 - PRP

This bit causes any WRITE or WEOF operation to be performed in the Prep mode. This function is used by special processors to initialize the disc packs to be used in the system and is available to the programmer as a means to perform custom preparation operations or recovering lost prep in a real-time environment.

3.10.3 ERROR CORRECTION MODE - BIT 9 - ERC

This bit specifies that this is a user error recovery operation to be attempted without retries using the method specified by Bits 10-13.

The field of Bits 10 through 13 is used when ERC is ON. It specifies which method is to be used during the user recovery operation. The valid codes for this field are:

```
0000 - Seek home, then normal try
0001 - Normal Try
0010 - Advance RST*
0011 - Retard RST
0100 - Move head offset forward
0101 - Move head offset reverse
0110 - Head offset forward and advance RST
0111 - Head offset forward and retard RST
1000 - Head offset reverse and advance RST
1001 - Head offset reverse and retard RST
1010 - Invoke ECC correction
1011 - Reset device fault, then normal try
1100 - Unassigned-normal try
1101 - Unassigned-normal try
1110 - Unassigned-normal try
1111 - Unassigned-normal try

* RST = Read strobe timing
```

Functions 0010 to 1010 are illegal for WRITE operations.

Functions 1100 to 1111 are illegal for all operations.

Functions 0000 and 1011 cause the specified action to be followed by normal (mode 0001) operations so that the necessary READ/WRITE transfers occur.

If ERC bit is OFF (Reset) then Bits 10 through 13 must be zero ('0000).

3.10.4 ADDRESSING MODE BITS 14-15

For privileged tasks, addressing modes other than the usual File Position Index (FPI) mode are available. These alternate addressing modes include:

- Logical Transport Device Position Index - LT DPI
- Sector/Track/Cylinder - STC
- Absolute Transport Device Position Index - ABS DPI

Figure 3-1 shows how these addressing modes are encoded.

Logical Transport Device Position Index (LT DPI) is a mode similar to the FPI except that it specifies a position relative to the start of the logical transport rather than relative to the start of a file.

Sector/Track/Cylinder (STC) mode is similar to ABS DPI except that it requires the use of a double word index and specifies the absolute sector and track in each half of the first word and the absolute cylinder in the second word.

Absolute Transport Device Position Index (ABS DPI) specifies an absolute position relative to the start of the physical transport.

NOTE: The concepts of geometry and partition size are not meaningful for these alternate addressing modes.

3.10.5 DDO BIT OF UFT OPTION WORD (UFTOPT)

Another device-dependent feature available to the user is the ability to read the extended status of the controller. This function is accomplished by setting the DDO bit (Bit 1 Device Dependent Option of UFTOPT) in the UFT and doing an ordinary READ operation. The UFT returned byte count word (UFTBCT) will contain the controller's primary status while the user buffer will contain up to 24 words of extended status. Those status words are described later in this chapter.

3.11 ERROR RECOVERY

Four modes of error recovery are available to the user. The mode is selected by SR and RNQ in the UFT option word as follows:

SR	RNQ	
Ø	Ø	Local recovery, without retries.
Ø	1	Local recovery, return after retries are attempted.
1	Ø	System recovery, place device offline after failure.
1	1	System recovery, as above except return if the operation cannot be queued.

If either bit is set, the retry sequences explained in the following paragraphs will be attempted so long as ERC mode is not used. When Error Correction Mode (ERC) is used the handler makes no retry attempts--it is expected that the user will specify the appropriate method to use to recover from any errors encountered.

If the user cannot tolerate having a file go "offline," the Ø1 (above) specification should be used. If a seek error occurs during READ or WRITE, a SEEK home is issued before any further error recovery is attempted.

3.11.1 READ ERRORS

This device has the capability to change the head position or the read timing for the purpose of error recovery, both of which are used by the handler. Additionally, the Error Correction Code (ECC) (also, Parity Error) correction is provided and supported. If the handler detects a read error and the user has requested it to attempt recovery, the following sequence occurs:

1. Do ECC correction on the data with otherwise normal retry conditions.
2. Advance read strobe timing.
3. Retard read strobe timing.
4. Move head offset forward. (Toward center of disc.)
5. Move head offset reverse. (Away from center of disc.)
6. Move head offset forward and advance read strobe timing.
7. Move head offset forward and retard read strobe timing.
8. Move head offset reverse and advance read strobe timing.
9. Move head offset reverse and retard read strobe timing.

ECC correction is enabled on all of the above operations.

If, on any retry, the operation is successful, the remaining sequence is skipped and control is returned to the user. If the entire sequence is unsuccessful and the user did not specify local recovery, the device is put offline.

3.11.2 AUTOMATIC ERROR RECOVERY

If the program addresses the disc using a file with Bit Ø (System Recovery) of the UFT option word set, automatic error recovery procedures are requested. The operation is retried if the following errors occur:

- Parity Error (ECC).
- Track Buffer (RAM) Parity Error.
- DMP memory parity.
- DMP failure to transmit the numbers of words it was told to transmit.
- Seek Error.
- Device (Drive fault).

NOTE: A condition exists for which the number of words transmitted does not equal the specified amount because an EOR signal was detected on an unlimited record size partition. This is not an error condition and is not reported as one. However, the total number of bytes actually transferred is updated in word 4 of the UFT (UFTBCT).

If the operation is still not successful after the retries, the handler puts the disc partition offline, thus causing the X TASK to inform the operator of the unrecoverable condition. The disc partition stays offline with all subsequent operations being diverted to the transport's "slough" queue until the operator makes a decision. This decision may be:

- To try again (up to a total of ten tries)
- To let the program proceed as if the operation were successful, or
- To abort the task using that partition.

If one of the following problems is encountered, the handler does not attempt retries but immediately informs the operator (if SR bit Ø of the UFTOPT set):

- Device inoperable (for example, power off).
- Watchdog timer expired after last operation initiated.
- Logic Plug missing.

A message reporting a holdup condition is output to the operator in the following format:

```
!xxx?/ttttttt/oooooo
```

xxx - is the name of the disc partition

tttttt - is the calling task's name

oooooo - is the current task overlay name

This message reports the following conditions:

- Device does not exist
- Device under exclusive use by another task
- Device already offline

3.11.3 USER ERROR RECOVERY

If the programmer did not set Bit Ø of the UFT option word, no error recovery is attempted; the programmer is immediately informed of the error condition by appropriate error bits being set in the UFT. The programmer must institute retry or device substitution operations in a manner appropriate to the application.

3.11.4 LOK ABORT

If a WRITE operation is attempted to a sector that is in the range of the enabled write-protect system, it is treated as a program error rather than a device error and the calling task is aborted with a reason code LOK.

3.11.5 EVENT LOGGING

The System Event Logging routines are called whenever disc problems are encountered and resolved by the handler. This is done so that degradation of system performance caused by disc problems does not go by unnoticed. Problems that are not resolved by the handler are reported and logged by other system routines.

On completion of an unsuccessful operation, the handler fetches and saves primary and extended status. It then updates a retry counter and either gives up if the counter is exhausted or retries the operation perhaps in some error recovery mode. On completion of a successful operation, the retry counter is checked, and if retries are indicated, the event logging routines are called. Various parameters are passed to these routines including one comprised of bits from the saved error status. The Device Dependent word is comprised of bits from the saved extended status Words 1 and 2. The format of the Device Dependent word is described below:

Ø	Unit refused selection attempt.
1	Selection refused due to other port selection/reservation.
2	Select acknowledge--indicated unit is selected.
3	Multiple units responding.
4	Illegal command received by controller.
5	WRITE attempted to protected area.
6	Sector specified is illegal.
7	Head specified is illegal.
8	Cylinder specified is illegal.
9	Unit failed to respond to offset command.
1Ø	Last Seek or SST command had no cylinder parameter.
11	Backup RAM buffer in use.
12	ECC head corrected an error.
13	Unit had a pack or logic plug changed.
14	Parity error in RAM buffer on READ operation.
15	Parity error in RAM buffer on WRITE operation.

A detailed description of the I/O Retry node format is contained in the EVENT LOGGING chapter of the MAX IV GENERAL OPERATING SYSTEM, System Guide Manual.

3.12 SYSTEM GENERATION

Disc drives using the CLASSIC Disc Device Handler (with the Models 4176A or 4180 controllers) can be SYSGENed as non-zero disc drive types, or as Type 0. The SYSGEN statements required to include the LX Handler in a MAX IV system are shown below. Detailed descriptions of these statements and the rules of order are included in the MAX IV SYSGEN, System Guide Manual.

3.12.1 NON-ZERO DISC DRIVE TYPE

The following statements are required to include the LX Handler in a MAX IV system. Refer to Table 3-1 to determine the value of Parameter 10 (drive type) for the FMTRANSPORT statement. Refer to the MAX IV SYSGEN, System Guide Manual for a description of the parameters omitted from the list below.

```
CONTROLLER      LX,3,3,TIMED

FMTRANSPORT     PH0,0,LX,,,,,[DPA],,[drive type]
LOGTRAN         H0,PH0,.....
FMTRANSPORT     PH1,1,LX,,,,,[DPA],,[drive type]
LOGTRAN         H1,PH1,.....
      .
      .
      .
DISCDEVICE      name,H0,...other parameters
      .
      .
      .
```

TYPE	SECTORS/ TRACK	HEADS	CYLINDERS	TOTAL TRACKS	UNFORMATTED CAPACITY
0	All alternate trackable devices				
1	42	19	411	7809	100MB
2	42	19	815	15485	200MB
3	64	19	411	7809	150MB
4	64	19	815	15485	300MB
5	64	19	823	15637	300MB
8@	64	4	200	800	16MB
9	64	5	411	2055	40MB
10+	64	5	823	4115	80MB
11*	64	10	823	8230	160MB
12*	64	2	320	640	12MB
13*	64	4	320	1280	24MB
14@	64	1	1646	1646	32MB

* Fixed Media Types
\+ Fixed or Removable Media Types
@ Mixed Media - Fixed and Removable Media

Table 3-1. CLASSIC Disc Drive Types

3.12.2 TYPE Ø DISC DRIVE

Type Ø disc packs must be prepared by the Alternate Track Initializer Program. The number of usable tracks must be identified to the Operating System at SYSGEN. This is done with the LOGTRAN statement.

The values specified for Parameter 4 on the LOGTRAN statements reflect the number of usable tracks seen by the Operating System for a logical transport. If multiple logical transports are defined for a physical transport, the total number of tracks specified in Parameter 4 (LOGTRAN statement) must equal the number of usable tracks on that physical transport.

```
CONTROLLER      LX,3,3,TIMED

FMTRANSPORT     PHØ,Ø,LX,,,,,[DPA],,Ø
LOGTRAN         HØ,PHØ,Ø,param4[,...]

DISCDEVICE      name,HØ,    other parameters
```

NOTE: LOGTRANS must:

- Specify contiguous areas
- NOT specify overlapped areas
- Specify the entire usable area

In Table 3-2 the following headings are used:

PHYSICAL CYLINDERS - the total number of cylinders on the physical media.

USABLE CYLINDERS - the physical CYLINDERS less the number of cylinders set aside for the spare track pool.

USABLE TRACKS - the number of tracks on the disc as seen by the Operating System. This number is the value to be used in the LOGTRANSPORT statement at SYSGEN. USABLE TRACKS = USABLE CYLINDERS * HEADS

UNFORMATTED CAPACITY	SECTOR/ TRACK	HEADS	USABLE CYLINDERS	PHYSICAL CYLINDERS	USABLE TRACKS	PHYSICAL TRACKS
.75MB	16	2	80	80	160	160
12MB*	64	2	305	320	610	640
16MB@	64	4	200	206	800	823
24MB*	64	4	305	320	1220	1280
27MB*	32	8	300	310	2400	2480
32MB@	64	2	808	823	1616	1646
40MB	64	5	400	411	2000	2055
80MB+	64	5	805	823	4025	4115
150MB	64	19	405	411	7695	7809
160MB*	64	10	812	823	8120	8230
300MB	64	19	809	815	15371	15485
300MB	64	19	817	823	15523	15637

* Fixed Media
+ Fixed or Removable Media
@ Mixed Media - Fixed and Removable Media

Table 3-2. CLASSIC Disc Drive Recommended Parameters for Type 0

Table 3-2 reflects that approximately 5 percent of the total disc capacity has been dedicated for alternate track allocation. This is a recommended amount. (See NOTE below.) The number of usable cylinders is determined by the system operator when the pack is prepared using the Alternate Track Initializer Program.

NOTE: The total number of tracks allocated for alternate tracking must not exceed the capacity of the controller's buffer. The controller's buffer space is 120 tracks per disc transport.

3.13 STATUS DESCRIPTION

3.13.1 NORMAL (PRIMARY) STATUS RETURNED IN UFTBCT

The normal, or primary, controller status word contents is described below. When the bits listed with an E above are set, the ERROR bit (Bit Ø, primary status word) will be reset.

When the bits listed with an L above are set, the LOOK bit (Bit 1, primary status word) will be set.

Bit Ø	1	E 2	E 3	E 4	5	E 6	7	8	9	1Ø	11	12	13	14	15
E	L	E	I	M	W	S	B	D	D	E	E	S	S	U	U
R	O	C	N	P	L	K	U	R	S	O	O	E	C	N	N
R	O	C	O	E	O		S	D	L	F	R	E	P	I	I
O	K		P			E	Y	Y				K	T	T	T
R		E				R			R						
		R				R			E						
		R							Q						

Figure 3-2. Primary Controller Status Word

BIT	NAME	DESCRIPTION IF SET
Ø	ERROR	Ø = One or more error conditions exist as indicated. 1 = No error condition exists.
1	LOOK	Examination of extended status is in order.
2	ECC ERR	Read or read-verification detected an ECC error.
3	INOP	Specified unit is inoperable.
4	MPE	I/O terminate was issued with bit 7 set.
5	WLO	Selected unit is positioned in a protected area.
6	SK ERR	Selected unit is lost and needs recalibration.
7	BUSY	Controller is busy executing some commanded function.
8	DRDY	Ø = Controller is ready to transfer a data word.
9	DSL REQ	Other port is requesting use of reserved unit(s).
1Ø	EOF	The last sector read had an End-Of-File written.

11	EOR	The last sector read had an End-Of-Record written.
12	SEEK	The selected unit is currently seeking.
13	SCPT	A continuous scan has found satisfied test condition(s).
14/15	UNIT	Bits 14 and 15 denote the currently selected unit's address.

3.13.2 EXTENDED CONTROLLER STATUS (FIRST FOUR WORDS)

Extended controller status consists of three actual status words and a fourth word whose function is primarily diagnostic in nature. This fourth word contains the last command (other than a FEX) received by the controller. The controller aborts illegal commands (those whose syntax it does not recognize) immediately, setting ERROR, LOOK, and Illegal Command; the "last command" word returns the command to the program for examination. The three extended controller status words are as follows:

3.13.2.1 Extended Controller Status--First Word

Bit	L Ø	L 1	2	EL 3	EL 4	EL 5	EL 6	EL 7	EL 8	EL 9	EL 10	L 11	L 12	L 13	14	15
	S	O	S	M	I	W	S	H	C	O	I	S	T	P	U	U
	E	P	A	U	L	L	C	D	Y	F	L	K	R	K	N	N
	L		C	L	L	O			L		L		Y		I	I
		S	K				N	N		F		C		C	T	T
	R	E		S	C	V	F	F	N	A	S	P	C	H		
	E	L		E	M	I			F	I	K	T	P	G		
	F			L	D	O				L			T			

Figure 3-3. First Extended Controller Status Word

BIT	NAME	DESCRIPTION IF SET
Ø	SEL REF	Drive refused this selection attempt.
1	OP SEL	Refusal due to selection/reservation by other port.
2	SACK	Select Acknowledge.
3	MUL SEL	Multiple units responding--possibly duplicate logic plugs.
4	ILL CMD	Last command issued had illegal syntax.
5	WLO VIO	Program attempted to write in protected area.

6	SC NF	Program specified illegal sector parameter.
7	HD NF	Program specified illegal head parameter.
8	CYL NF	Program specified illegal cylinder parameter.
9	OF FAIL	Drive failed to respond to offset command.
10	ILL SK	Last seek or SST had no cylinder parameter.
11	SK CPT	Completed scan found seeked drive on cylinder.
12	TRY CPT	Completed scan found select TRY'd unit responding.
13	PK CHG	Currently selected unit had a pack change.
14/15	UNIT	Bits 14 and 15 denote the currently selected unit's address.

3.13.2.2 Extended Controller Status--Second Word

Bit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	LBACK	LCOR	DI CONN	SI CONN	REL RD BFE	REL WR BFE	REL SK IP	D	MOVE				DSSLRQ	DSSLRQ	DSSLRQ	DSSLRQ
	U P	E C C	C O N N	C O N N	B F E	F E	P	I A G	D N M A P	M A P	Ø	Ø	R Q	R Q	R Q	R Q
													3	2	1	Ø

Figure 3-4. Second Extended Controller Status Word

BIT	NAME	DESCRIPTION IF SET
Ø	BACKUP	Controller has switched to backup RAM data buffer.
1	COR ECC	ECC read detected and corrected an error.
2	DI CONN	DI is currently connected.
3	SI CONN	SI is currently connected.
4	RD BFE	Read operation detected a RAM parity error.
5	WR BFE	Write operation detected and recorded a RAM error. Read operation detected a recorded RAM error.
6	SK IP	Operation not attempted because drive already seeking.

7	DIAG	Controller is in diagnostic (RAM test) mode.
8	MOD MAP	No MODCOMP alternate track error map was found.
9	VEN MAP	No vendor track map was found.
10-11		Not used.
12-15	DSLRQ X	Deselect request. Sharing CPU wants these physical units.

3.13.2.3 Extended Controller Status--Third Word

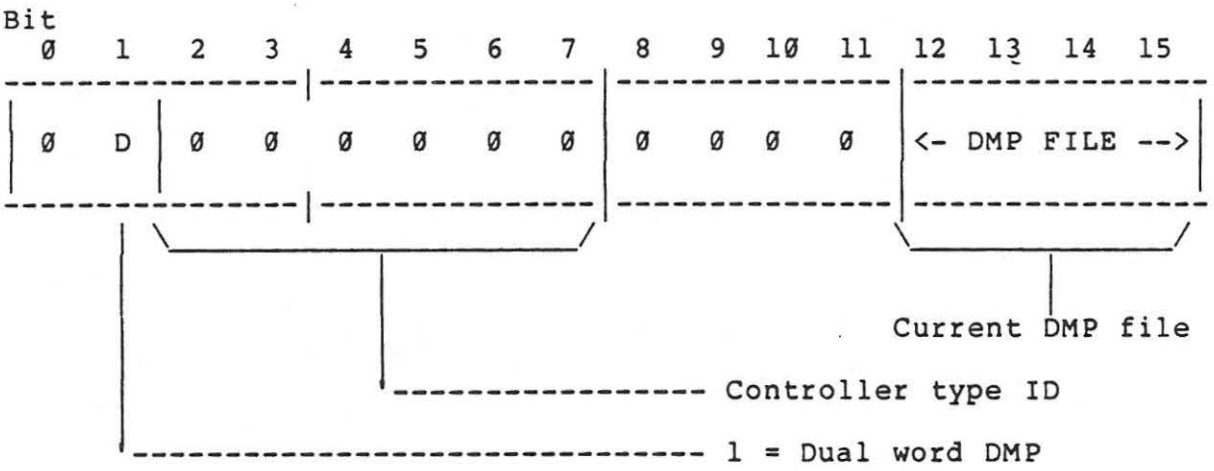

Figure 3-5. Third Extended Controller Status Word

This status word is common to all extended controllers and provides system-level identification information. The controller type ID is a binary code used to identify the controller's type and hence its capabilities to the program. The code 00 0000 (#00) identifies the CLASSIC Moving-Head Disc Controller. The current DMP file is to guide the program in the use of more controllers than it has DMP channels available.

3.13.2.4 Extended Controller Status--Fourth Word

This word contains the last command received by the controller other than FEX.

3.13.3 EXTENDED DEVICE STATUS (FOUR WORDS)

Each drive unit has its own extended status word; each word carries the same information for its respective drive as follows:

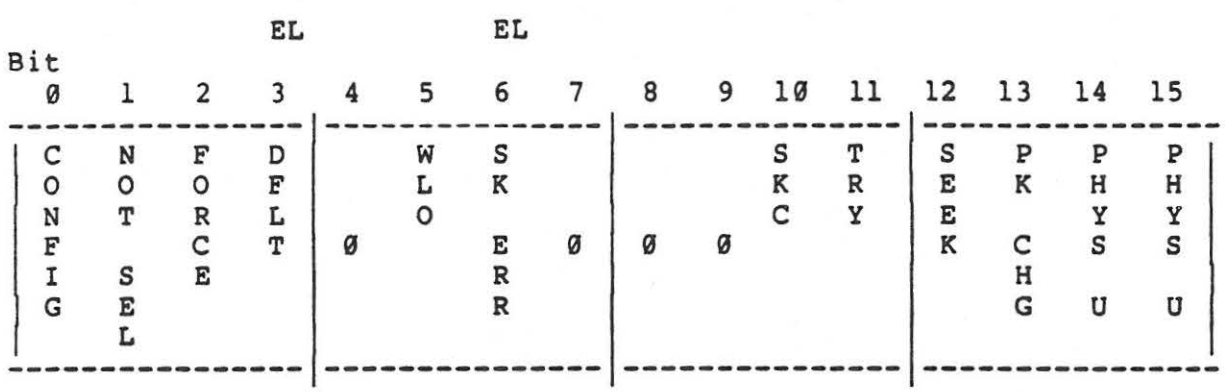

Figure 3-6. Extended Device Status Word

BIT	NAME	DESCRIPTION IF SET
0	CONFIG	Device is configured.
1	NOT SEL	Unit not currently responding to selection.
2	FORCE	Unit currently force-reserved to this controller.
3	DFLT	Unit is sensing a fault condition (INOP).
5	WLO	Unit's "Read Only" switch is set.
6	SK ERR	Unit is lost and needs recalibration.
10	SKC	Seek Complete Scan Interrupt pending.
11	TRY	Commanded Select TRY has not yet received response.
12	SEEK	Unit is currently seeking.
13	PK CHG	Unit has had a pack change.
14/15	PHYS U	Physical unit responding to this logical address.

NOTE: The physical unit response address is included to assist the program in monitoring logic plug changes and reestablishing its unit identification accordingly.

Bits 10 and 11 record pending Scan Complete interrupt conditions. When a Select TRY is commanded, TRY (Bit 11) is set until used to stop a scan or until selection has been gained by other means (Unit Select, Seek, Recalibrate, or SST), thereby negating the need for the TRY interrupt. Likewise, SKC (Bit 10) is set by a Seek or Recalibrate and remains set until Seek Complete stops a scan or until execution of a successful SST. Note: SKC may be set after the unit completes its seek if neither of the above conditions has occurred.

3.13.4 UNIT IDENTIFICATION STATUS

The ninth through twenty-fourth extended status words contain four groups of four words each describing the relevant unit. In all cases, the information is given as a binary number right justified in the word or byte; the value given represents the number of the highest available sector, head, or cylinder. This information relates to the physical unit number! To determine the parameters for a particular logical unit, the program must read unit status and make the necessary correlation between logical and physical addresses by using Bits 14 and 15 of the relevant logical unit's status.

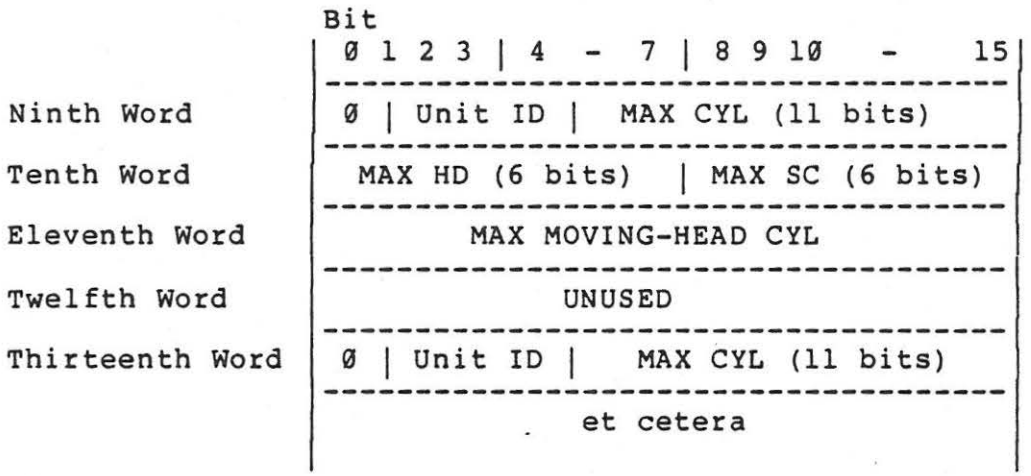
Bit
0 1 2 3 | 4 - 7 | 8 9 10 - 15
Ninth Word
0 | Unit ID | MAX CYL (11 bits)
Tenth Word
MAX HD (6 bits) | MAX SC (6 bits)
Eleventh Word
MAX MOVING-HEAD CYL
Twelfth Word
UNUSED
Thirteenth Word
0 | Unit ID | MAX CYL (11 bits)
et cetera

Figure 3-7. Unit Identification Status Word

	ASCII MODES		BINARY MODES	
	STANDARD	NONSTANDARD	STANDARD	NONSTANDARD
0 READ	INPUT ONE SECTOR (STOP TRANSMISSION IF USER'S BUFFER SMALLER) OR INPUT ONE MULTISECTOR BLOCK.*	<------SAME	<-----SAME	<-----SAME
1 WRITE	OUTPUT ONE SECTOR (STOP TRANSMISSION IF USER'S BUFFER SMALLER) OR OUTPUT ONE MULTISECTOR BUFFER.*	<------SAME	<-----SAME	<-----SAME
2 REWIND	LOGICALLY REWIND PARTITION'S FILE TO SECTOR 0. SETS EOF AND BOM EVENT BITS IN UFT STATUS.	<-----SAME	<-----SAME	<------SAME
3 BKFILE	LOGICALLY BACKSPACE PARTITION'S FILE AND READ SECTORS UNTIL FILE MARK SECTOR OR SECTOR 0 FOUND.	<-----SAME	<-----SAME	<------SAME
4 BKRECORD	LOGICALLY BACKSPACE PARTITION'S FILE AND READ TO SEE IF IT IS A FILE MARK SECTOR.	<-----SAME	<-----SAME	<------SAME
5 AVRECORD	LOGICALLY ADVANCE PARTITION'S FILE AND READ TO SEE IF IT IS A FILE MARK SECTOR.	<-----SAME	<-----SAME	<-----SAME
6 AVFILE	LOGICALLY ADVANCE PARTITION'S FILE AND READ UNTIL FILE MARK SECTOR OR LAST SECTOR (EOM) DETECTED.	<-----SAME	<-----SAME	<-----SAME
7 WEOF	OUTPUT ONE RECORD WITH ($$NUL...) AND FILE MARK (EOF) STATUS BIT SET IN HARDWARE POSTAMBLE AND UFT STATUS.	<-----SAME	<-----SAME	<-----SAME
8 HOME	SETS EOF AND BOM EVENT BITS IN UFT STATUS WORD.	<-----SAME	<-----SAME	<------SAME

* Special partition for large multisector records.

Table 3-3. CLASSIC Disc Operations and Modes

PROGRAMMER'S ERROR BIT IN UFTSTA	OPERATOR'S REASON CODE	REASON FOR ERROR IF SET
0	ER	SOME ERROR EXISTS.
1	OVF	LOOK AT EXTENDED STATUS.
2	PAR PARITY OR DATA CHECK	PARITY (ECC) ERROR OCCURRED.
3	INO INOPERABLE	-DEVICE DOES NOT EXIST OR DOES NOT RESPOND. -DEVICE INOPERABLE. -WATCHDOG TIMER HAS EXPIRED.
4	MPE MEMORY PARITY	-MEMORY PARITY ERROR DETECTED WHILE DMP WAS TRANSMITTING DATA TO/FROM MEMORY. -INVALID BUFFER ARGUMENTS WERE SPECIFIED.
5	LOK WRITE LOCK	-WRITE OPERATION ATTEMPTED TO A PROTECTED AREA.
6	CIG "CHARACTER IN GAP"/SEEK ERROR	-ONE OR MORE SECTORS HAVE LOST THE PREAMBLE (PREP) INFORMATION. THIS CONDITION IS NOT REPORTED UNTIL AFTER RETRIES IF SYSTEM RECOVERY SPECIFIED. -SEEK ERROR. THIS CONDITION IS NOT REPORTED UNTIL AFTER RETRIES IF SYSTEM RECOVERY SPECIFIED.
7	OTH OTHER	OPERATION WITH LOCAL RECOVERY WOULD HAVE ABORTED IF SYSTEM RECOVERY HAD BEEN SPECIFIED.
8	HOL HOLD	DMP FAILED TO TRANSMIT NUMBER OF WORDS SPECIFIED (WHEN THE NUMBER OF WORDS TRANSMITTED DOES NOT EQUAL SPECIFIED AMOUNT ON A LIMITED DISC PARTITION).
PROGRAMMER'S EVENT BIT IN UFTSTA	**REASON CODE**	**REASON FOR EVENT IF SET**
9	EOM END-OF-MEDIUM	SET WHEN LAST SECTOR OF PARTITION IS ACCESSED.
10	EOF END-OF-FILE	-SET AFTER WEOF, REWIND, OR HOME OPERATION. -SET WHEN A FILE-MARK SECTOR IS ACCESSED BY READ, ADVANCE, OR BACKSPACE OPERATION. -SET WHEN BACKSPACE OPERATION ATTEMPTS ACCESS AT PARTITION START.
11	BOM BEGINNING-OF-MEDIUM	-SET AFTER REWIND OR HOME OPERATION. -SET WHEN BACKSPACE FILE OR RECORD BACKSPACES TO THE BEGINNING OF THE DISC PARTITION. -SET WHEN A READ OPERATION DETECTS AN END-OF-RECORD MARK.

Table 3-4. CLASSIC Disc Errors and Events

CHAPTER 4
MAX IV FIXED AND MOVING-HEAD DISC HANDLERS
(FHn, CDn, CXn, MPn, MXn, FLn)

The disc handler consists of the TASK level and directly connected DATA and SERVICE interrupt routines. The DATA interrupt is used for Direct Memory Processor (DMP) END-OF-BLOCK detection. The DATA and SERVICE interrupts use unique hardware party-line interrupt vectors. These are permanent resident elements so that they are always available without delay. The elements are capable of controlling the transfer of data, status, and commands to/from a disc/drum controller. The hardware controller and handler support up to four pack transports (drives). The floppy-disc hardware supports only two pack transports. Since these drives share the same controller channel and DMP, they all share the same queue, permitting only one operation at a time to be initiated. Each drive provides its own media control allowing one pack to be the "system" pack and others to be used for data storage expansion. Additional controllers can be added if packs must have separate data paths and queues. A single copy of the handler will serve all packs of all controllers if each controller is assigned its own unique group/unit number.

The standard controller names for system generation purposes and their standard device and DMP addresses are given in the description of the SYSGEN statements. A DMP is required for data transmissions directly to/from memory because of the very high data transfer rate. The data interrupt level is used as an end-of-block interrupt that occurs when the DMP finishes transmitting a block of data.

Timing of disc operations is more unpredictable for the moving-head discs than for the fixed-head discs because of the variable time necessary to move heads to the desired cylinder. Within a particular cylinder, however, all tracks can be addressed with timing similar to the fixed-head disc.

4.1 DISC PARTITIONS

Each physical transport may be partitioned into one or more logical transports and each logical transport may be partitioned into many logical devices. Each logical device has its own independent addressing mode and error control. Most partitions can be made to simulate the sequential operation of a unit record magnetic tape when addressed by the programmer. However, these partitions can be addressed in a random access manner if the programmer chooses. Some partitions can be addressed only in a random manner with indefinite unit record (sector) sizes. The naming conventions for logical disc partitions are described in the MAX IV BASIC I/O SYSTEM, System Guide Manual.

The assignment of partitions on a moving-head disc is more complicated than on fixed-head discs, since the most frequently used partitions need to be assigned to the same or adjacent cylinders (usually near the center of the disc) to minimize head movement.

Each disc partition has its own entry in the logical device list. Each also has its own unit record definition (words per sector or unlimited sector size) and its own addressing geometry. Partitions can even overlap the same disc media space assigned to other partitions, giving the same disc area more than one set of rules that can be chosen by simply assigning the programmer's file to the appropriate partition.

4.2 DISC CAPACITY

The fixed-head disc transports are available with 16 sectors per revolution (track) or 32 sectors per revolution, where a sector consists of 128 words (256 bytes). The number of tracks is variable from 64 tracks to 512 tracks. Usually all pack transports on the same controller must be of the same type and size. A pack with 16 sectors per revolution can address a total of 2,048 words in one revolution (track) while the large packs can address 4,096 words per revolution (track).

The cartridge moving-head disc has 32 sectors per revolution, where a sector consists of 100 words (200 bytes). The head assembly has two heads "in contact" with two surfaces (one platter) making a cylinder address two tracks without head movement. The head can move into 203 unique positions (cylinders) giving a total of 406 tracks of 3,200 words each.

The large-pack moving-head disc has 24 sectors per revolution, where a sector consists of 128 words (256 bytes). The head assembly has 20 heads "in contact" with 20 surfaces (eleven platters), making a cylinder address 20 tracks without head movement. The head can move into either 203 or 406 unique positions (cylinders), giving a total of either 4,060 or 8,120 tracks of 3,072 words each. The larger packs are called "double density" packs. These devices do not automatically increment to the next cylinder for multisector I/O operations that span more than one cylinder. If this occurs a CIG error will be returned.

The floppy moving-head disc has 16 sectors per revolution, where a sector consists of 128 words (256 bytes). The head assembly has one head in contact with the disc surface. The head can move into 77 unique positions giving a total of 77 tracks with a total of 2,048 words each.

4.3 WRITE PROTECT

The first pack (pack Ø) of a controller has hardware write-protection switches that cover all or part of the pack. This pack is usually reserved as the "system" pack so that the read-only system elements (for example, libraries, macros) can be hardware protected. This pack can also be accessed by the hardware FILL switch and a small area is usually reserved for "fillable" programs such as diagnostics and stand-alone loaders. Two types of hardware protection are available with various discs. One type assigns a switch for each eight tracks. A maximum of eight switches allows the first 64 tracks to be write protected in discrete groups. The other type of protect system also has eight protect switches that are arranged so that they can select a binary track boundary between Ø and 255. This allows a larger area of disc (up to 256 tracks) to be protected in one contiguous block.

The first pack (pack Ø) of each floppy disc controller has hardware write-protection and FILL capability. One or both packs of each floppy-disc controller may be write protected. Two switches (one for each pack) are provided on the controller front panel to enable or disable the write protection. The entire surface of each floppy pack is protected when enabled.

The handler and the I/O system also provide for software write protection for those areas of the pack and other packs where hardware write protection is not available.

4.4 GEOMETRY

Addressing geometry, which is a software controlled feature, permits the sector number (unit record number) used by the programmer to be different from the hardware sector number chosen by the handler. This feature is useful when the programs are using the disc as a general purpose SEQUENTIAL device and it is desired to maximize the number of sectors that can be accessed within a physical revolution of the disc.

Normally, it is impossible to address each adjacent sector as it passes the heads because the intersector gap time is only a few microseconds. If the disc is being programmed so that each record is a sector, then the overhead of the handler itself does not provide enough time for selecting the "next" sector after all error checking and shutdown functions are performed for the "previous" sector, even when the "next" operation is already queued. To make the matter worse, most programs are not capable of, or choose not to attempt, the double- or triple-buffering necessary to keep the "next" operation always in a queued state. In most cases, there may even be a substantial amount of data processing that a program must do between sequential record accesses.

For this reason, it is usually best that a disc revolution be addressed on alternate sectors per revolution. The variable geometry that can be defined for a partition allows this concept. Let us assume a geometry of 2 is SYSGENed as an example. As the program addresses "sequential" sectors, it is actually addressing only the even sector numbers on the first revolution and odd sectors on the next revolution but it can access all of a track without losing additional revolutions for each sector access.

As the average amount of time spent processing the records between sequential accesses goes up, a point is reached that causes the loss of revolution times again for each sector. If your program falls in this class, it more efficiently addresses a partition if the geometry is 4 or 8. Although it takes four or eight revolutions to address an entire track, it is much faster, by a factor of 4 or 8, than missing every revolution. These geometry algorithms are illustrated in Figures 4-1 through 4-5.

Direct hardware geometry (1) may be useful when a special application program must address the disc in blocks larger than a sector. The partition record size must be specified as zero (unlimited). In this case, the concept of a sector must still be used to address the start of a record, but a record can be any integral number of sectors up to 16,384 words in length. An optional hardware detectable End-of-Record (EOR) mark may be written in the last sector of such multi-sector records to facilitate automatic termination during READ operations. When this type of partition is defined, the programmer must compute the start of his multi-sector records by keeping in mind the actual sector boundaries.

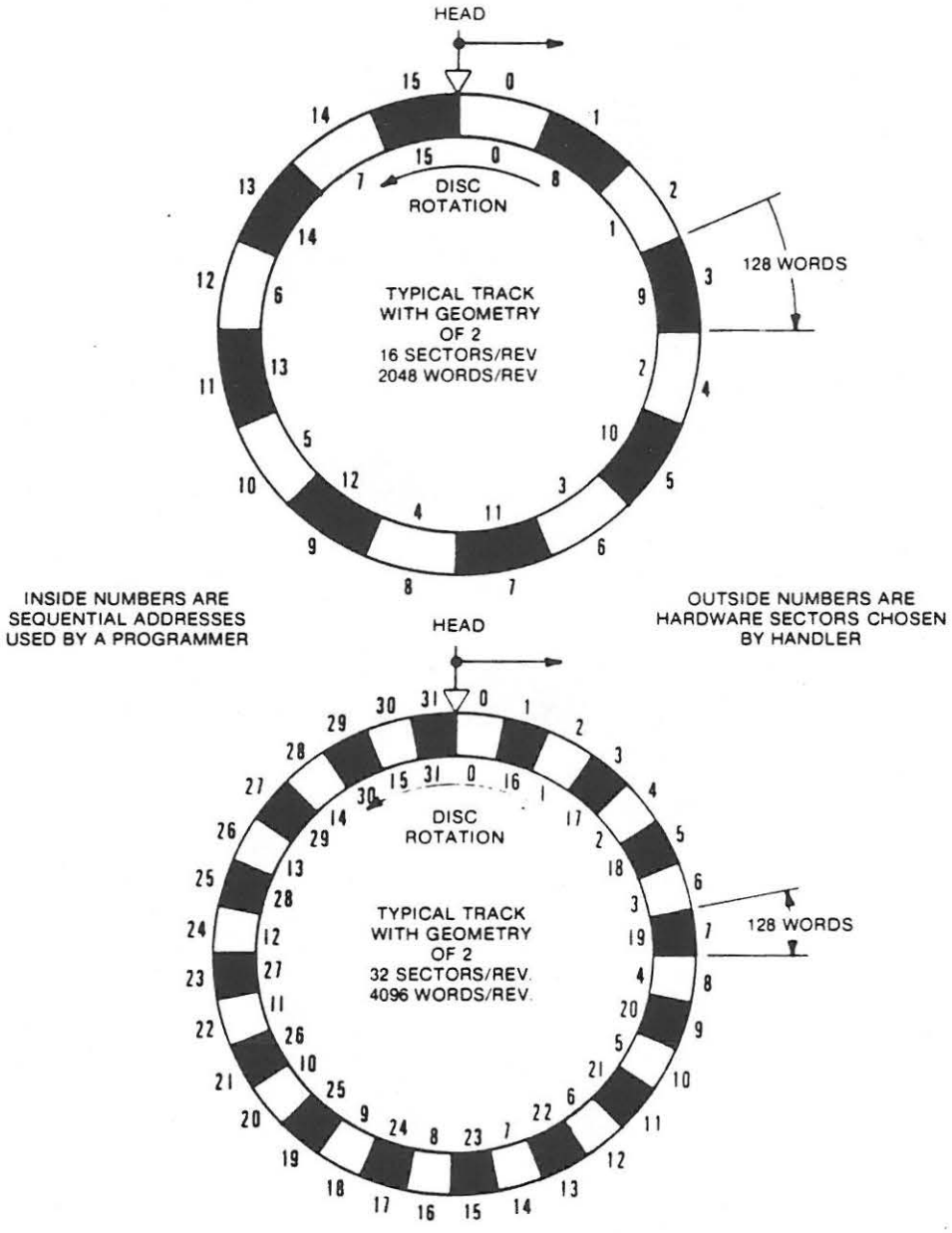
HEAD
DISC ROTATION
TYPICAL TRACK WITH GEOMETRY OF 2 16 SECTORS/REV 2048 WORDS/REV
128 WORDS
INSIDE NUMBERS ARE SEQUENTIAL ADDRESSES USED BY A PROGRAMMER
OUTSIDE NUMBERS ARE HARDWARE SECTORS CHOSEN BY HANDLER
HEAD
DISC ROTATION
TYPICAL TRACK WITH GEOMETRY OF 2 32 SECTORS/REV 4096 WORDS/REV
128 WORDS

Figure 4-1. Fixed-Head Disc Addressing (Geometry 2).

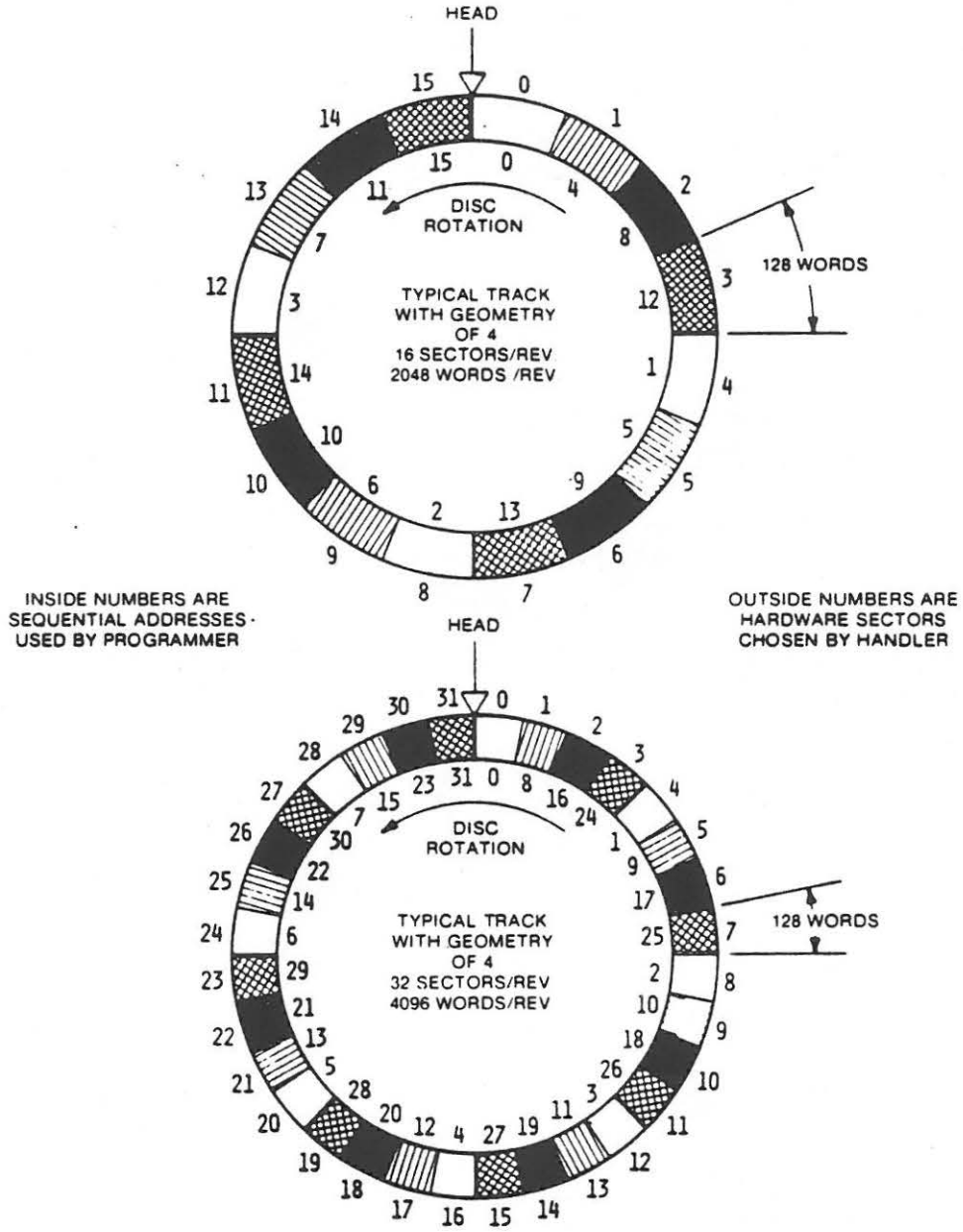
HEAD
DISC ROTATION
TYPICAL TRACK WITH GEOMETRY OF 4 16 SECTORS/REV 2048 WORDS /REV
128 WORDS
INSIDE NUMBERS ARE SEQUENTIAL ADDRESSES USED BY PROGRAMMER
OUTSIDE NUMBERS ARE HARDWARE SECTORS CHOSEN BY HANDLER
HEAD
DISC ROTATION
TYPICAL TRACK WITH GEOMETRY OF 4 32 SECTORS/REV 4096 WORDS/REV
128 WORDS

Figure 4-2. Fixed-Head Disc Addressing (Geometry 4).

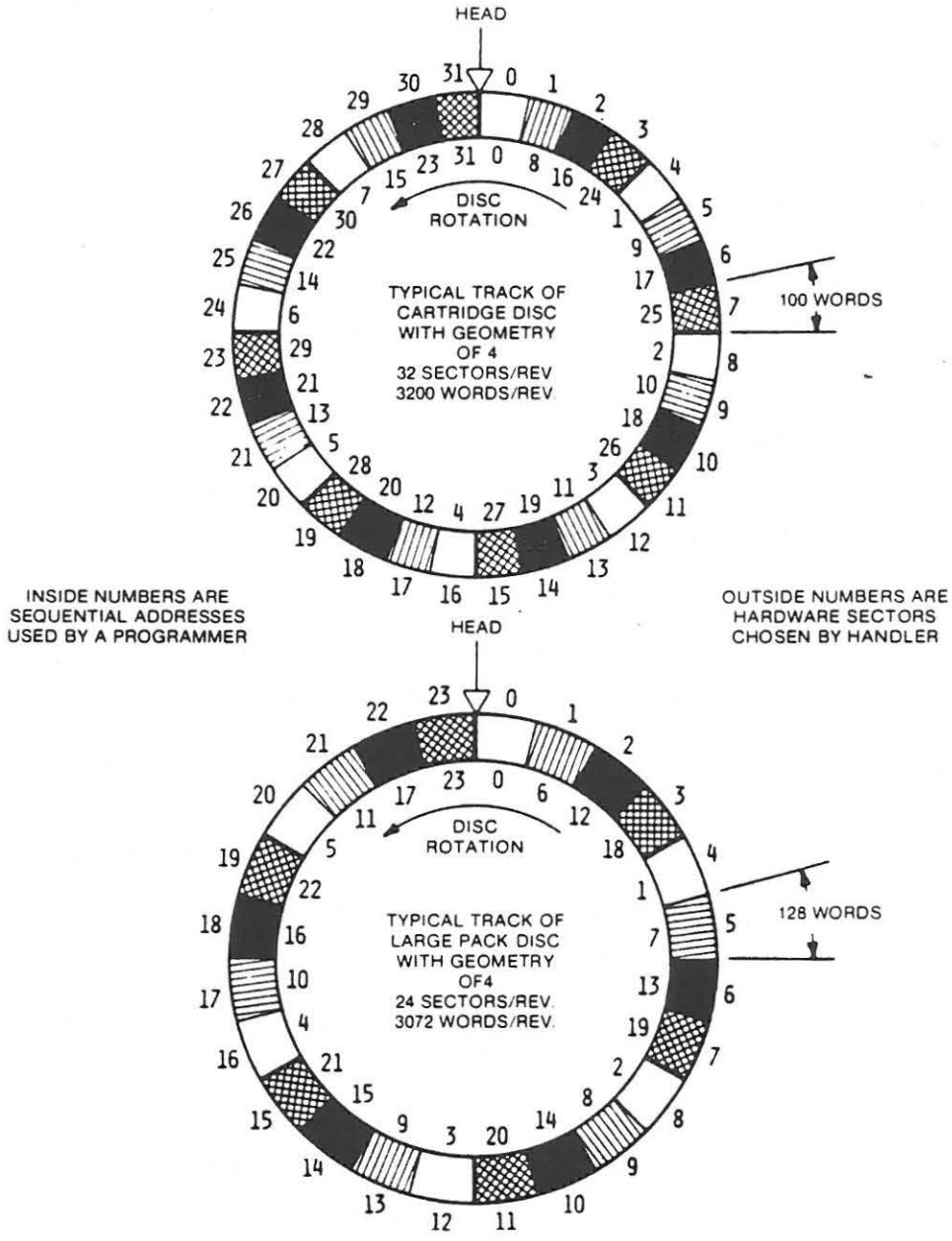

Figure 4-3. Moving-Head Disc Addressing (Geometry 4).

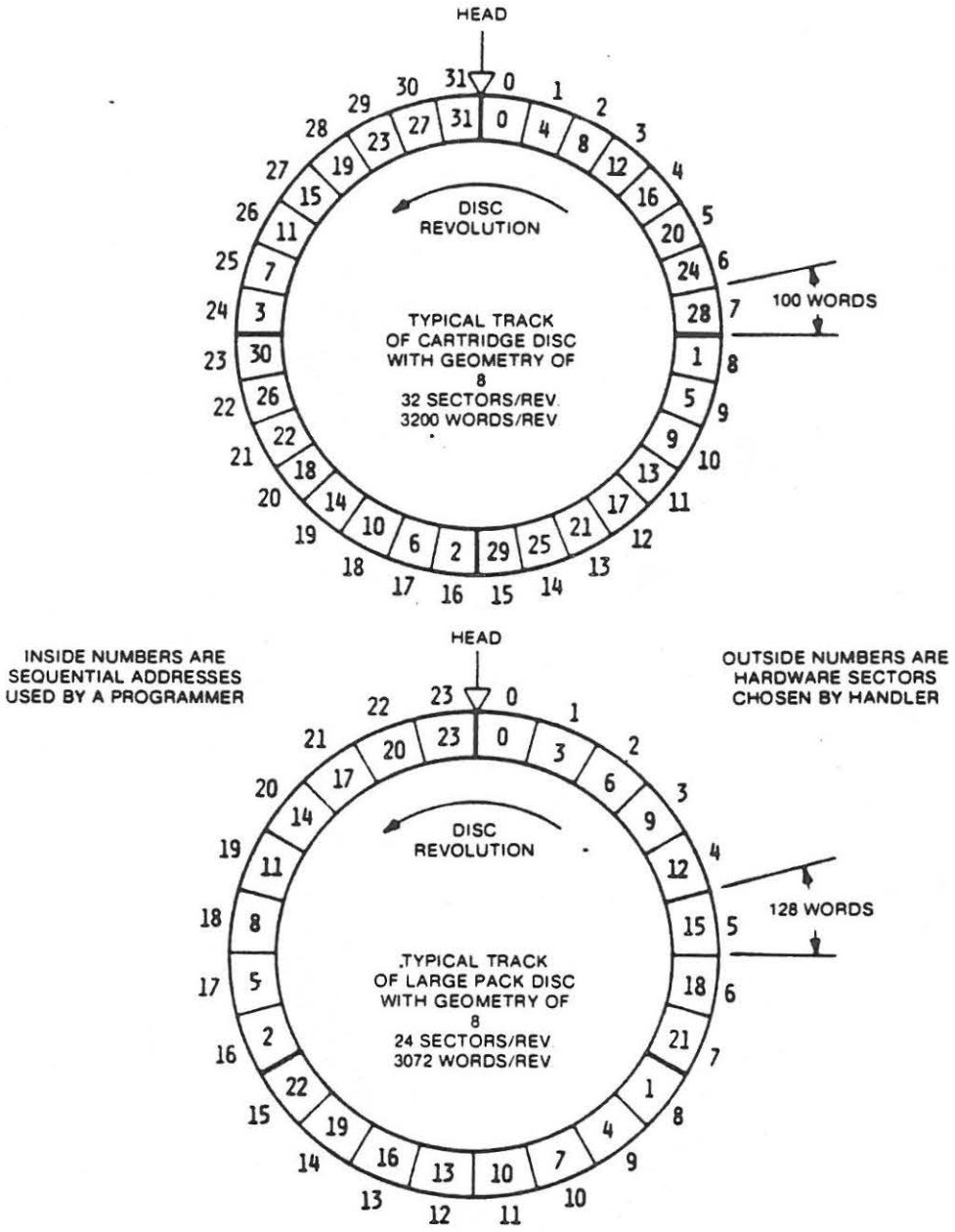

Figure 4-4. Moving-Head Disc Addressing (Geometry 8).

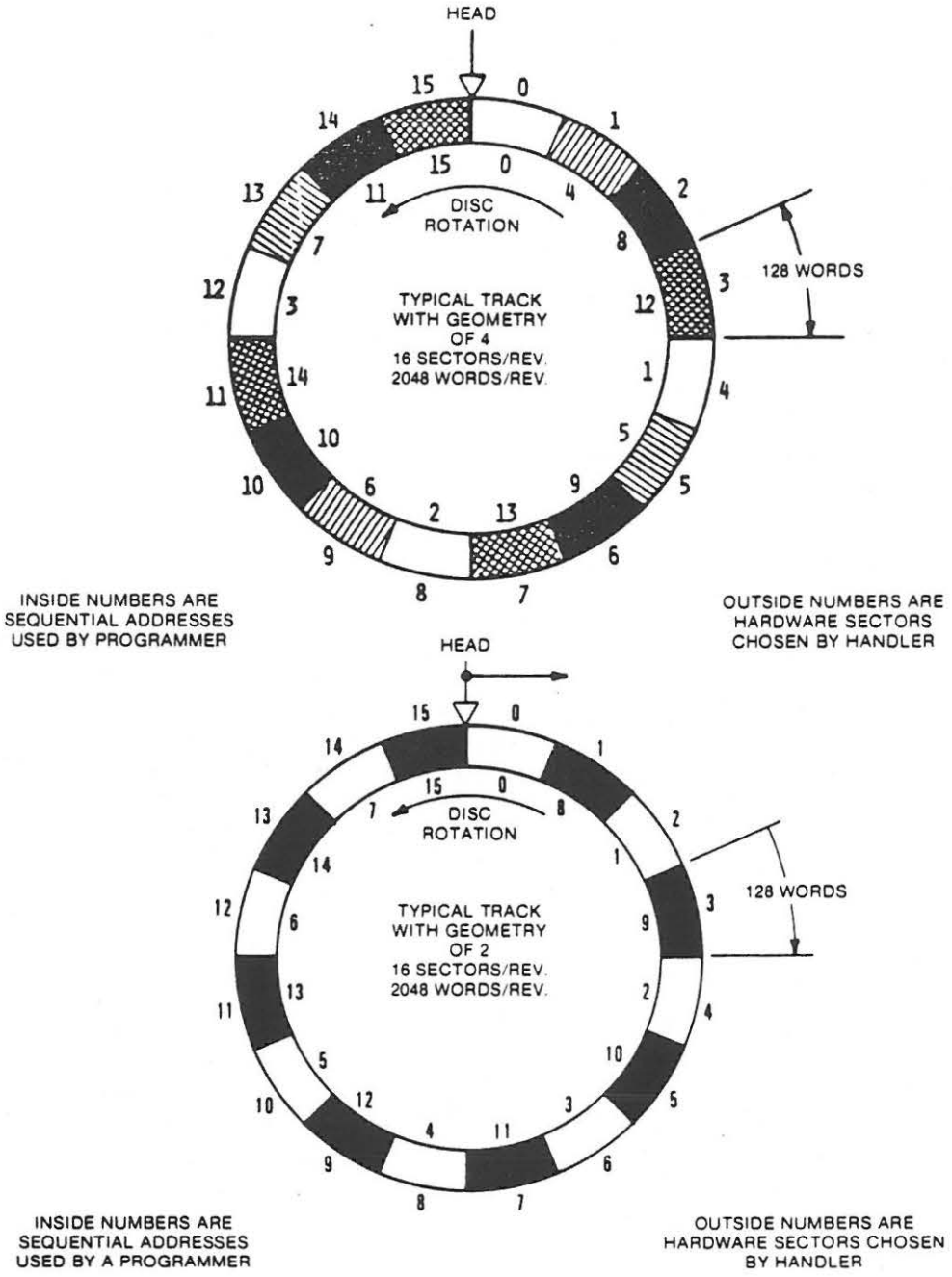
HEAD
DISC ROTATION
TYPICAL TRACK WITH GEOMETRY OF 4 16 SECTORS/REV. 2048 WORDS/REV.
128 WORDS
INSIDE NUMBERS ARE SEQUENTIAL ADDRESSES USED BY PROGRAMMER
OUTSIDE NUMBERS ARE HARDWARE SECTORS CHOSEN BY HANDLER
HEAD
DISC ROTATION
TYPICAL TRACK WITH GEOMETRY OF 2 16 SECTORS/REV. 2048 WORDS/REV.
128 WORDS
INSIDE NUMBERS ARE SEQUENTIAL ADDRESSES USED BY A PROGRAMMER
OUTSIDE NUMBERS ARE HARDWARE SECTORS CHOSEN BY HANDLER

Figure 4-5. Floppy Disc Addressing (Geometry 2).

4.5 RESPONSES TO OPERATIONS AND MODES

The following operation descriptions refer to disc partitions limited to sector sized unit records, except as noted. All four modes of operation, that is, Standard ASCII, Non-Standard ASCII, Standard Binary, and Non-Standard Binary are identical to this handler.

4.5.1 FPI ABORT

Any READ, WRITE, WEOF, ADVANCE RECORD or ADVANCE FILE operation that attempts to access a sector beyond the end of the partition causes the calling task to be aborted with a reason code of FPI and a WHAT code of the logical file name.

4.5.2 EOM

Any READ, WRITE, WEOF, ADVANCE RECORD or ADVANCE FILE operation to the last sector of a partition causes the EOM event bit to be set.

4.5.3 READ FROM DISC PARTITION

The READ operation causes one sector to be read into the programmer's buffer. If the size of the buffer specified by the programmer is equal to or smaller than a sector, the transfer is terminated at the specified word count (even number of bytes). If the size of the buffer is larger than a sector, only a sector is transmitted. If the program is written in a "device-independent" manner but tries to adjust to device record size, the programmer can call the I/O INFORMATION service to find the sector size and adjust the program logic accordingly.

4.5.3.1 Unlimited Record Size

If the partition has been specified to have an unlimited record size, a buffer size of up to 16,384 words (limit of one DMP transfer) can be specified with one READ operation. However, if a sector is encountered in the range of the READ that has an End-of-Record (EOR) mark set, the DMP transfer and disc read operation terminate automatically at the end of this marked sector and the BOM event bit is set.

4.5.3.2 File Position Index

The sector (starting sector for unlimited record size partitions) that is accessed during a READ operation is determined by the RANDOM flag, bit 5 in the UFT option word (UFTOPT). If this bit is reset, a sequential access method is assumed and the current File Position Index (FPI) that is maintained in the File Assign Table (FAT) entry is used as the relative sector number. This number is converted by the handler to a hardware sector number that is appropriate for the partition's defined geometry. When the READ

operation is successfully completed, the FPI value is incremented so that the next operation to this file will be to the next logical sector. This incremented value is then moved to the programmer's User File Table (UFT). If the RANDOM flag is set, a random access method is assumed and the FPI in the programmer's UFT is used directly as the desired logical sector number. Again, this is converted to the actual physical sector by the handler's geometry algorithm. When the READ operation is successfully completed, the FPI in the UFT is incremented.

It can be easily seen that, if the programmer never modifies the FPI in the UFT after initially setting it, sequential operation occurs thereafter by default, even in the RANDOM access mode until the programmer modifies the FPI in the UFT. It should also be obvious since addressing of a partition is maintained at the UFT or file level, the programmer may keep many unique sequential pointers within the same disc partition by assigning the partition to a different file name for each independent index desired.

For partitions with unlimited record size, the sequential index system is useless, particularly in a sequential mode, because it always points to the next logical sector. When such partitions are being used with records larger than a sector, the "next" sequential record may be accessed by the programmer manually incrementing the UFT's FPI by an amount equal to the number of hardware sectors contained in each record. Only the RANDOM access mode and a geometry of 1 are convenient for such usage unless the record size is exactly two, four, or eight sectors, in which case a geometry of 2, 4, or 8 might be convenient.

4.5.3.3 NULL Word

Since this device is a DMP device, the NUL markers (two NUL bytes on a word boundary) that can mark the end-of-useful information in the buffer are not interpreted by the WRITE command. However, since this marker is written on disc, a READ operation causes it to again appear in the READ buffer as data, allowing any syntax analysis routines that depend on it to find it in the normal place at the end of useful information.

If a sector was originally written with a WEOF operation, the EOF event bit in the programmer's UFT is set when the sector is read. The programmer's buffer also has the ASCII value '$$' stored in bytes 0 and 1 and two NUL bytes stored in bytes 2 and 3.

4.5.4 WRITE TO DISC PARTITION

The WRITE operation causes one sector to be written to the disc. If the size of the programmer's buffer is equal to or less than the partition's sector size in words (even number of bytes), the exact number of words specified is transmitted. If the buffer is larger than a sector, only a sector is written and the remainder of the data in the programmer's buffer is ignored.

If the partition has been specified to have an unlimited sector size, a buffer size of up to 16,384 words (limit of one DMP transfer) can be specified with one WRITE operation. An EOR mark is automatically written in the last sector that falls within the write range if this feature has been SYSGENed for the partition (see DISCDEVICE SYSGEN statement) or optioned in the UFT (Bit 7 of Extended UFT Option Word (XUFOPT)). This flag causes a multisector READ operation to terminate short of its specified buffer size if this sector is encountered before the specified block size is satisfied.

The sector (starting sector for unlimited record size partition) to be accessed during the WRITE operation is determined in exactly the same manner as in the READ operation.

4.5.5 REWIND AND HOME TO DISC PARTITION

The REWIND and HOME operations do not transmit any data to the disc, but the disc partition must not be offline when the operations are specified. The HOME operation is a null operation. The REWIND operation resets the File Position Index to zero in the program's UFT and in the File Assign Table entry. HOME and REWIND cause the EOF and BOM event bits to be set in the UFT status word.

One of these operations is appropriate at the beginning of a program when device-independent conventions are being followed by the programmer. HOME must be used instead of REWIND when the position of the FPI (next addressable sector) is not to be changed.

4.5.6 BACKSPACE RECORD TO DISC PARTITION

The BACKSPACE RECORD operation subtracts one from the FPI and then reads the logical software sector. The physical sector is computed by the same algorithm used for the READ operations. A two-word buffer built into the handler is used for this operation so that the programmer does not have to set aside a buffer. When the READ operation is complete, the FPI is set to the sector just read, so that this is the next sector accessed on the next forward operation.

If the accessed sector was a file-mark record ($$), the EOF bit is set in the programmer's UFT. Backspacing a disc sequentially is slow since it is retrograde to the direction of a revolution; however, the function is often convenient when device-independence is the programmer's goal. If backspacing beyond sector Ø is attempted, no operation occurs and the EOF and BOM bits are set in the UFT.

4.5.7 BACKSPACE FILE TO DISC PARTITION

The BACKSPACE FILE operation is similar to BACKSPACE RECORD except that the process continues until a file-mark record or beginning-of-media (sector Ø) is found. The operation node is dequeued at the end of each disc record and then requeued so that higher priority operations on the disc controller can take precedence over its completion.

4.5.8 ADVANCE RECORD TO DISC PARTITION

The ADVANCE RECORD operation is similar to BACKSPACE RECORD except that the File Position Index is incremented in a forward direction. The operation is as fast as a READ operation, and it sets the EOF event bit in the programmer's UFT if a file-mark record is encountered. If the last sector of the partition is encountered, the EOM event bit is also set.

4.5.9 ADVANCE FILE TO DISC PARTITION

The ADVANCE FILE operation is similar to BACKSPACE RECORD except that the FPI is incremented in a forward direction. This operation continues until a file-mark record or End-of-Media (last sector of partition) is detected. The appropriate bits are set in the programmer's UFT. The operation node is dequeued at the end of each disc record and then requeued so that higher priority operations on the disc controller can take precedence over its completion.

4.5.1Ø WEOF TO DISC PARTITION

The WEOF operation causes the addressed sector, as specified by the current FPI, to be written with the EOF hardware flag set in the sector. A four-byte buffer containing the bytes $,$,NUL,NUL is written and the remainder of the sector is wasted. The FPI is incremented by one and the EOF event bit is set in the UFT word UFTSTA. If the last sector of a partition is written, the EOM event bit is set.

4.5.11 SUMMARY TABLES

Fixed and Moving-Head Disc Handlers summary tables appear at the end of this chapter. Table 4-1 contains information about the handler's response to I/O operations in the four modes of data transfer. Table 4-2 lists the error and event bits in the UFT status word (UFTSTA). Conditions causing the error or event are also listed.

4.6 UFT OPTIONS

There are several features available as options. Most of the options are specified in the UFT at execution time by bits in the Device Dependent Option field of XUFOPT. Figure 4-6 shows the extended UFT Option Word, XUFOPT.

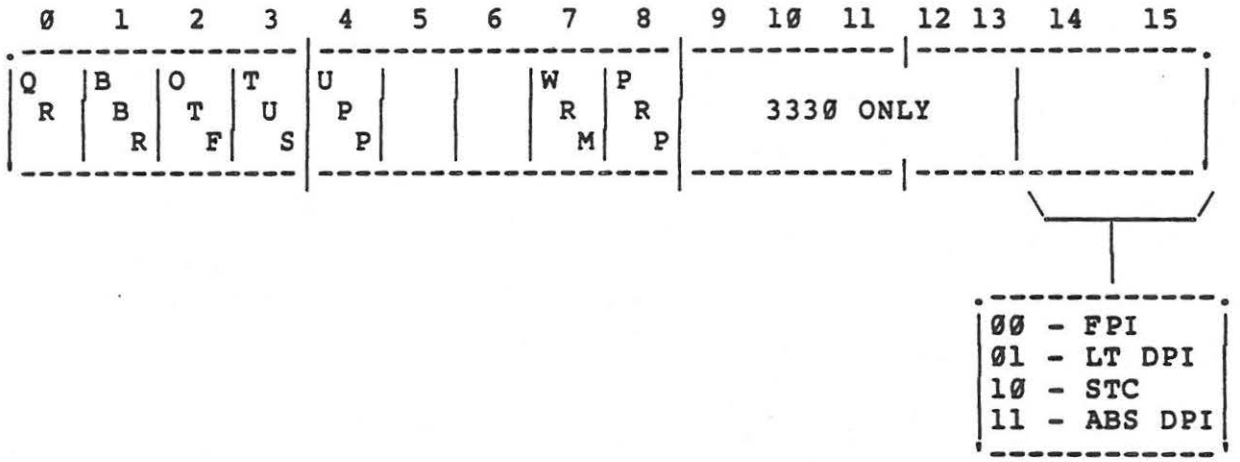

Figure 4-6. Extended UFT Option Word (XUFOPT)

4.6.1 WRITE RECORD MARK - BIT 7 - WRM

A WRITE or WEOF operation to a partition does not cause an End-of-Record (EOR) mark to be added to the last sector of the record unless either the DISCDEVICE SYSGEN statement specifies its unconditional addition or this bit is set in the UFT (XUFOPT). Once an EOR mark has been written, a READ operation on that record cannot progress beyond the sector containing the EOR. These marks are generally used only when a partition has an unlimited record size and the programmer wishes to use the EOR detection capability to delimit the records. To indicate detection of an EOR on a READ, the BOM bit in the UFT status word is set.

4.6.2 PREP - BIT 8 - PRP

This bit causes any WRITE or WEOF operation to be performed in the Prep mode. This function is used by special processors to initialize the disc packs to be used in the system and is available to the programmer as a means to perform custom preparation operations or recovering lost prep in a real-time environment.

4.6.3 ADDRESSING MODES - BITS 14-15

For privileged tasks, addressing modes other than the usual File Position Index (FPI) mode are available. These alternate addressing modes include:

- Logical Transport Device Position Index - LT DPI
- Sector/Track/Cylinder - STC
- Absolute Transport Device Partition Index - ABS DPI

Figure 4-6 shows how these addressing modes are encoded.

Device Position Index (LT DPI) is a mode similar to the ABS DPI except that it specifies a position relative to the start of the logical transport rather than relative to the start of the physical transport.

Sector/Track/Cylinder (STC) mode is similar to ABS DPI except that it requires the use of a double word index and specifies the absolute sector and track in each half of the first word and the absolute cylinder in the second word.

Absolute Transport Device Position Index (ABS DPI) specifies an absolute position relative to the start of the physical transport.

NOTE: The concept of geometry and partition size are not meaningful for these alternate addressing modes.

4.7 ERROR RECOVERY

4.7.1 AUTOMATIC ERROR RECOVERY

If the program addresses the disc with Bit 0 of the UFT option word set, automatic error recovery procedures are requested. The operation is retried up to eight times if the following errors occur:

- Data rate overflow/underflow
- Checksum error (parity)
- DMP memory parity
- DMP failure to transmit the numbers of words it was told to transmit
- Seek Error (moving-head discs only)

NOTE: There is a condition where the number of words transmitted does not equal the specified amount because an EOR signal was detected (on an unlimited record size partition). This is not an error condition and is not reported as one. However, the total number of bytes actually transferred is updated in the UFT, Word 4.

If the operation is still not successful after eight tries, the handler "gives up" and puts the disc partition offline, thus causing the system to inform the "operator" of the unrecoverable condition. The disc partition stays offline with all subsequent operations being diverted to the partition's "slough" queue until the operator makes a decision. This decision may be:

- To try again (up to eight more times)
- To let the program proceed as if the operation were successful, or
- To abort the task using that partition.

If the device is a floppy-disc and a parity error (CRC) occurs on a read or a read-before-write operation, the handler attempts to recover by first seeking back one track, seeking forward one track, and then attempting the operation again. If a parity error still occurs, the handler attempts to recover by seeking forward one track, seeking backward one track, and then attempting the operation again. If the operation is still not successful, the handler puts the disc partition offline. The optional watchdog timer sets the device inoperable if approximately 0.64 seconds have elapsed without a service interrupt since the previously initiated operation. This time is greater than the worst case seek-plus-write-time for typical real-time clock frequencies (200 Hz).-

If one of the following errors occurs, the handler does not attempt eight retries but immediately informs the operator (if bit 0 of UFT option word set).

- Device inoperable (for example, power off)
- Device media failure (scarred track)
- Watchdog timer expires approximately 10 seconds after last operation optional)

A message reporting a holdup condition is output to the operator in the following format:

```
!xxx?/tttttt/oooooo
```

xxx - is the name of disc partition

tttttt - is the calling task's name

oooooo - is the current task overlay name

This message reports the following conditions:

- Device does not exist
- Device under exclusive use by another task
- Device already offline

4.7.2 USER ERROR RECOVERY

If the programmer did not set Bit Ø of the UFT option word, no error recovery is attempted but the programmer is immediately informed of the error condition by appropriate error bits being set in the UFT. The programmer must institute retry or device substitution operations, in a manner appropriate to the application.

4.7.3 LOK ABORT

If a WRITE operation is attempted to a sector that is in the range of the enabled write-protect system, it is treated as a programmer error rather than a device error and the calling task is aborted with a reason code LOK.

4.7.4 EVENT LOGGING

The System Event Logging routines are called whenever disc problems are encountered and resolved by the handler. This is done so that degradation of system performance caused by disc problems does not go by unnoticed. Problems that are not resolved by the handler are reported and logged by other system routines.

On completion of an unsuccessful operation, the handler fetches and saves primary and extended status. It then updates a retry counter and either gives up if the counter is exhausted or retries the operation perhaps in some error recovery mode. On completion of a successful operation, the retry counter is checked, and if retries are indicated, the event logging routines are called. Various parameters are passed to these routines including one comprised of bits from the saved error status. The following are the words, in order, that are passed to the logging routines.

- High order part of two-word time stamp.
- Low order part of two-word time stamp.
- Negative retry count.
- REX service number.
- Sector and Track involved in operation.
- Cylinder involved in operation.
- Transport name.
- Primary status saved after last error detection.
- Device Dependent word (Ø).
- First half of Task name.
- Second half of Task name.

A detailed description is contained in the EVENT LOGGING chapter of the MAX IV GENERAL OPERATING SYSTEM, System Guide Manual.

4.8 SYSTEM GENERATION

The following statements are required in a system generation source file if the appropriate device is to be included in a system. Detailed descriptions of these statements and the rules of order are included in The MAX IV SYSGEN, System Guide Manual.

4.8.1 FIXED HEAD DISC STATEMENTS

```
CONTROLLER      FHn,2,#A,TIMED (MODEL 4103,4104,4106)
      .
      .
      .
FMTRANS         PF0,0,FHn
FMTRANS         PF1,1,FHn
      .
      .
      .
LOGTRANS        F0,PF0,...
LOGTRANS        F1,PF1,...
      .
      .
      .
DISCDEVICE      name,F0,...
DISCDEVICE      name,F0,...
      .
      .
      .
DISCDEVICE      name,F1,...
```

4.8.2 CARTRIDGE MOVING-HEAD DISC STATEMENTS

```
CONTROLLER      CDn,1,1,TIMED (MODEL 4126,4127,4128,4129)
     or
CONTROLLER      CXn,1,1,TIMED (200 TPI. MODEL 4136,4137)
      .
      .
      .
FMTRANS         PM0,0,CDn
FMTRANS         PM1,1,CDn
     or
FMTRANS         PM0,0,CXn
FMTRANS         PM1,1,CXn
      .
      .
LOGTRANS        M0,PM0,...
LOGTRANS        M1,PM1,...
      .
      .
DISCDEVICE      name,M0,...other parameters
      .
      .
      .
```

4.8.3 LARGE-PACK MOVING-HEAD DISC STATEMENTS

```
CONTROLLER      MPn,3,3,TIMED (MODEL 4132,4133)
     or
CONTROLLER      MXn,3,3,TIMED (MODEL 4134,4135)
      .
      .
      .
FMTRANS         PDB,Ø,MPn
FMTRANS         PDD,1,MPn
      .
      .
LOGTRANS        DB,PDB,...
LOGTRANS        DD,PDD,...
      .
      .
DISCDEVICE      name,DB,...other parameters
      .
      .
      .
```

4.8.4 FLOPPY MOVING-HEAD DISC STATEMENTS

```
CONTROLLER      FLn,9,3,TIMED (MODEL 4521,4522)
      .
      .
      .
FMTRANS         PPØ,Ø,FLn
FMTRANS         PP1,1,FLn
      .
      .
LOGTRANS        PØ,PPØ,...
LOGTRANS        P1,PP1,...
      .
      .
      .
DISCDEVICE      name,PØ,...other parameters
```

FIXED OR MOVEABLE-HEAD DISCS

RANDOM OR SEQUENTIAL ADDRESSING

RECORD SIZE ≤ 256 BYTES
OR ≤ 200 BYTES
SPECIAL *OR ≤ 32768 BYTES

	ASCII MODES		BINARY MODES	
	STANDARD	NON-STANDARD	STANDARD	NON-STANDARD
0 READ	INPUT ONE SECTOR (STOP TRANSMISSION IF USER'S BUFFER SMALLER) OR (INPUT ONE MULTISECTOR BLOCK.*)	<------SAME	<-----SAME	<-----SAME
1 WRITE	OUTPUT ONE SECTOR (STOP TRANSMISSION IF USER'S BUFFER SMALLER) OR (OUTPUT ONE MULTISECTOR BUFFER.*)	<------SAME	<-----SAME	<-----SAME
2 REWIND	LOGICALLY REWIND PARTITION'S FILE TO SECTOR 0. +	<-----SAME	<-----SAME	<-----SAME
3 BKFILE	LOGICALLY BACKSPACE PARTITION'S FILE AND READING SECTORS TILL FILE MARK SECTOR OR SECTOR 0 FOUND.	<-----SAME	<-----SAME	<-----SAME
4 BKRECORD	LOGICALLY BACKSPACE PARTITION'S FILE AND READ TO SEE IF IT IS A FILE MARK SECTOR.	<-----SAME	<-----SAME	<-----SAME
5 AVRECORD	LOGICALLY ADVANCE PARTITION'S FILE AND READ TO SEE IF IT IS A FILE MARK SECTOR.	<-----SAME	<-----SAME	<-----SAME
6 AVFILE	LOGICALLY ADVANCE PARTITION'S FILE AND READ UNTIL FILE MARK SECTOR OR LAST SECTOR (EOM) DETECTED.	<-----SAME	<-----SAME	<-----SAME
7 WEOF	OUTPUT ONE RECORD WITH ($$NUL...) AND FILE MARK (EOF) STATUS BIT SET IN HARDWARE POSTAMBLE AND UFT STATUS.	<-----SAME	<-----SAME	<-----SAME
8 HOME	null+	<-----SAME	<-----SAME	<-----SAME

* Special partition for large multisector records.
\+ This operation sets EOF and BOM event bits in UFT status word.

Table 4-1. Fixed and Moving-Head Disc Operations and Modes

PROGRAMMER'S ERROR BIT IN UFTSTA	OPERATOR'S REASON CODE	REASON FOR ERROR IF SET
0	ER	SOME ERROR EXISTS
1	OVF OVERFLOW/ UNDERFLOW	HIGHER PRIORITY DMP'S HAVE USED TOO MUCH CPU TIME; THIS ERROR CONDITION WILL NOT BE REPORTED TILL AFTER EIGHT RETRIES IF SYSTEM RECOVERY SPECIFIED.
2	PAR PARITY OR DATA CHECK	DISC CHECKSUM ERROR ON READ - ERROR CONDITION WILL NOT BE REPORTED TILL AFTER EIGHT RETRIES IF SYSTEM RECOVERY IS SPECIFIED.
3	INO INOPERABLE	-DEVICE DOES NOT EXIST -DEVICE INOPERABLE (POWER OFF OR UNLOADED) -WATCHDOG TIMER HAS EXPIRED
4	MPE MEMORY PARITY OR IOP ERROR	-MEMORY PARITY ERROR DETECTED WHILE DMP WAS TRANSMITTING DATA TO/FROM MEMORY -INVALID BUFFER ARGUMENTS WERE SPECIFIED
5	LOK WRITE LOCK	WRITE ATTEMPTED IN TRACK WHICH IS COVERED BY A WRITE PROTECT SWITCH (THIS ERROR ABORTS TASK IF SYSTEM RECOVERY SPECIFIED)
6	CIG CHARACTER IN GAP	-ONE OR MORE SECTORS HAVE LOST THE PREAMBLE (PREP) INFORMATION. THIS CONDITION IS NOT REPORTED TILL AFTER EIGHT RETRIES IF SYSTEM RECOVERY SPECIFIED. -SEEK ERROR- THIS CONDITION IS NOT REPORTED TILL AFTER EIGHT RETRIES IF SYSTEM RECOVERY SPECIFIED. (THIS DOES NOT APPLY TO FIXED-HEAD DISCS.) -CYLINDER INCREMENT ERROR- THIS CONDITION OCCURS WHEN A 25 MB OR A 50 MB DISC, WHICH DOES NOT SUPPORT AUTO CYLINDER INCREMENT, IS REQUESTED TO PERFORM AN I/O OPERATION THAT SPANS MORE THAN ONE CYLINDER.
7	OTH OTHER	-NONE-
8	HOL HOLD	DMP FAILED TO TRANSMIT NUMBER OF WORDS IT WAS TOLD TO TRANSMIT (WHEN THE NUMBER OF WORDS TRANSMITTED DOES NOT EQUAL SPECIFIED AMOUNT REQUESTED ON A LIMITED DISC PARTITION ONLY).

PROGRAMMER'S EVENT BIT IN UFTSTA	REASON CODE	REASON FOR EVENT IF SET
9	EOM END-OF-MEDIUM	SET WHEN LAST SECTOR OF PARTITION IS ACCESSED.
10	EOF END-OF FILE	-SET AFTER WEOF, REWIND, OR HOME OPERATION. -SET WHEN A FILE-MARK SECTOR IS ACCESSED BY READ, ADVANCE, OR BACKSPACE OPERATION. -SET WHEN BACKSPACE OPERATION IS ATTEMPTED WHILE CURRENTLY POSITIONED AT THE BEGINNING OF A DISC PARTITION.
11	BOM BEGINNING- OF-MEDIUM	-SET AFTER REWIND OR HOME OPERATION. -SET WHEN BACKSPACE FILE OR RECORD BACKSPACES TO THE BEGINNING OF THE DISC PARTITION. -SET WHEN A READ OPERATION DETECTS AN END-OF-RECORD MARKER.

Table 4-2. Fixed and Moving-Head Disc Errors and Events

CHAPTER 5
MAX IV LARGE CAPACITY MOVING-HEAD DISC HANDLER (LDn)

This handler's basic structure (the three levels of execution) is the same as it is for all handlers. The disc handler consists of the directly connected DATA and SERVICE interrupt routines and shares the TASK level routine used by the Fixed- and Moving-Head Disc handler. The DATA interrupt is used for Direct Memory Processor (DMP) End-of-Block detection. The DATA and SERVICE interrupts use unique party line interrupt vectors. These are permanent resident elements so that they are always available without delay. The elements are capable of controlling the transfer of data, status, and commands to/from the 4138 disc controller. The hardware controller and handler support up to four transports (drives). Since these drives share the same controller channel and DMP, they all share the same queue, permitting only one operation at a time to be initiated. Each drive provides its own media control, allowing one drive to be the system drive and others to be used for data storage expansion.

The SYSGEN requirements, for the most part, are the same as other disc devices except where additional options are available. The standard controller names for system generation purposes and their standard device and DMP addresses are given in the description of the SYSGEN statements.

Additional controllers can be added if drives must have separate data paths and queues. A single copy of the handler will serve all drives of all controllers if each controller is assigned its own unique group/unit number.

A DMP is required for data transmissions directly to/from memory because of the very high data transfer rate. The data interrupt level is used as an end-of-block interrupt which occurs when the DMP finishes transmitting a block of data.

5.1 DISC PARTITIONS

Each physical transport may be partitioned into one or more logical transports and each logical transport may be partitioned into many logical devices, each with its own independent addressing mode and error control. Most partitions can be made to simulate the sequential operation of a unit record magnetic tape when addressed by the programmer. However, these partitions can be addressed in a random access manner if the programmer chooses. Some partitions can be addressed in a random manner with indefinite unit record (sector) sizes. The naming conventions for logical disc partitions are described the MAX IV BASIC I/O SYSTEM, System Guide Manual.

The assignment of partitions on a disc with moving heads is more complicated than on fixed-head discs, since the most frequently used partitions need to be assigned to the same or adjacent cylinders (usually near the center of the disc) to minimize head movement.

Each disc partition has its own entry in the logical device list. Each partition also has its own unit record definition (words per sector or unlimited sector size) and its own addressing geometry. Partitions can even overlap the same disc media space assigned to other partitions, giving the same disc area more than one set of rules which can be chosen by simply assigning the programmer's file to the appropriate partition.

5.2 DISC CAPACITY

The large-capacity moving-head disc has either 42 or 64 sectors per revolution, where a sector consists of 128 words (256 bytes). The head assembly has either 6 or 20 heads in contact with either 6 or 20 surfaces (3 or 10 platters). This device stores timing information on one entire surface of a pack that allows addressing of only 5 or 19 tracks without head movement. The head can move into either 411, 815 or 823 unique positions (cylinders).

5.3 WRITE PROTECT

The first drive (drive 0) of a controller has hardware write-protection switches that cover all or part of the drive. This drive is usually reserved as the system drive so that the read-only system elements (for example, libraries, macros) can be hardware protected. This drive can also be accessed by the hardware FILL switch and a small area is usually reserved for fillable programs such as diagnostics and stand-alone loaders.

The protect system has eight protect switches that are arranged so that they can select a binary cylinder boundary between 0 and 255. This allows an area of disc (up to 256 cylinders) to be protected in one contiguous block. There is also a switch which allows the entire transport to be protected.

The handler and the I/O system also provide for software write protection for those areas of the pack and other packs where hardware write protection is not available.

5.4 TRANSFER MODES

The controller for the Model 4138 employs a full track buffer in the form of a RAM file. There are two modes of transfer available in the hardware. These are the Track and Record mode. In the Track Mode, each time an initial transfer is requested for a track, the entire track is loaded into the RAM. Subsequent transfer requests will be made between memory and the RAM without a transfer

occurring to the disc. In the Record Mode, only the data requested is loaded into the RAM and then into memory.

Whenever an I/O request is made by the programmer, the handler will use Record Mode for all output transfers and Track Mode for all input transfers. The handler does not normally use Track Mode for output operations because the current implementation of the controller provides no means of ensuring data integrity during power failure.

5.5 GEOMETRY

Addressing geometry, which is a software controlled feature, permits the sector number (unit record number) used by the programmer to be different from the hardware sector number chosen by the handler. This feature is useful when the programs are using the disc as a general-purpose sequential device and it is desired to maximize the number of sectors that can be accessed within a physical revolution of the disc.

Normally, it is impossible to address each adjacent sector as it passes the heads because the intersector gap time is only a few microseconds. If the disc is being programmed so that each record is a sector, then the overhead of the handler itself does not provide enough time for selecting the next sector after all error checking and shutdown functions are performed for the previous sector, even when the next operation is already queued. To make the matter worse, most programs are not capable of, or choose not to attempt, the double- or triple-buffering necessary to keep the next operation always in a queued state. In most cases, there may even be a substantial amount of data processing that a program must do between sequential record accesses.

For this reason, it is usually best that a disc revolution be addressed on alternate sectors per revolution. The variable geometry that can be defined for a partition allows this concept. For example, let us look at a geometry of two. As the programmer addresses sequential sectors, he/she is actually addressing only the even sector numbers on the first revolution and odd sectors on the next revolution but he/she can access all of a track without losing additional revolutions for each sector access.

As the average amount of time spent processing the records between sequential accesses goes up, a point is reached that again causes the loss of a revolution for each sector. If your program falls in this class, it will more efficiently address a partition if the geometry is greater. Although it takes more revolutions to address an entire track, it is much faster than missing every revolution. For this device a geometry of 14 or 20 is preferred.

Direct hardware geometry (1) may be useful when a special application program must address the disc in blocks larger than a sector. The partition record size must be specified as zero (unlimited). In this case, the concept of a sector must still be used to address the start of a record, but a record can be any integral number of sectors up to 16,384 words in length. An

optional hardware detectable End-of-Record (EOR) mark may be written in the last sector of such multi-sector records to facilitate automatic termination during READ operations. When this type of partition is defined, the programmer must compute the start of the multi-sector records by keeping in mind the actual sector boundaries.

5.6 DUAL PORT OPTION

This device provides a dual port option a feature whereby two computers may gain access to the same device on a first-in-first-out basis. Any one or all of the units on a controller may be dual ported. If the user chooses the dual port adapter, the hardware deselect timer for those units to be dual ported must be set at 1/2 second. For normal operation, the Large Capacity Disc handler supports this option as a transparent feature. However, some applications require the ability to exert control over a dual-ported device in a device dependent environment. This requires the use of an inter-processor exclusive use service. This service is dependent upon the provision of a generalized processor-to-processor communication system service and whatever additional hardware is required by the system service. Therefore, there will be no inter-processor exclusive use with this handler.

5.7 RESPONSES TO OPERATIONS AND MODES

The following operation descriptions refer to disc partitions limited to sector-sized unit records, except as noted. All four modes of operation, that is, Standard ASCII, Non-Standard ASCII, Standard Binary, and Non-Standard Binary are identical to this handler.

5.7.1 FPI ABORT

Any READ, WRITE, WEOF, ADVANCE RECORD or ADVANCE FILE operation that attempts to access a sector beyond the end of the partition causes the calling task to be aborted with a reason code of FPI and a WHAT code of the logical file name.

5.7.2 EOM

Any READ, WRITE, WEOF, ADVANCE RECORD or ADVANCE FILE operation to the last sector of a partition causes the EOM event bit to be set.

5.7.3 READ FROM DISC PARTITION

The READ operation causes one sector to be read into the programmer's buffer. All reads are done in track mode. If the size of the buffer specified by the programmer is equal to or smaller than a sector, the transfer is terminated at the specified word count (even number of bytes). If the size of the buffer is larger than a sector, only a sector is transmitted. If the program

is written in a device-independent manner but tries to adjust to device record size, the programmer can call the I/O INFORMATION service to find the sector size and adjust the program logic accordingly.

5.7.3.1 Unlimited Record Size

If the partition has been specified to have an unlimited record size, a buffer size of up to 16,384 words (limit of one DMP transfer) can be specified with one READ operation. However, if a sector is encountered in the range of the READ that has an End-of-Record (EOR) marker set, the DMP transfer and disc READ operation terminate automatically at the end of this marked sector and the BOM event bit is set.

5.7.3.2 File Position Index

The sector (starting sector for unlimited record size partitions) that is accessed during a READ operation is determined by the RANDOM flag, Bit 5 in the UFT option word (UFTOPT). If this bit is reset, a sequential access method is assumed and the current File Position Index (FPI) that is maintained in the File Assign Table (FAT) entry is used as the relative sector number. This number is converted by the handler to a hardware sector number that is appropriate for the partition's defined geometry. When the READ operation is succesfully completed, the FPI value is incremented so that the next operation to this file will be to the next logical sector. This incremented value is then moved to the programmer's User File Table (UFT). If the RANDOM flag is set, a random access method is assumed and the FPI in the programmer's UFT is used directly as the desired logical sector number. Again, this is converted to the actual physical sector by the handler's geometry algorithm. When the READ operation is successfully completed, the FPI in the UFT is incremented.

It can be easily seen that if the programmer never modifies the FPI in the UFT after initially setting it, sequential operation occurs thereafter by default, even in the RAMDOM access mode, until the programmer modifies the FPI in the UFT. It should also be obvious that since addressing of a partition is maintained at the UFT or file level, the programmer may keep many unique sequential pointers within the same disc partition by assigning the partition to a different file name for each independent index desired.

For partitions with unlimited record size, the sequential index system is useless, particularly in a sequential mode, because it always points to the next logical sector. When such partitions are being used with records larger than a sector, the next sequential record may be accessed by the programmer manually incrementing the UFT's FPI by an amount equal to the number of hardware sectors contained in each record. Only the RANDOM access mode and a geometry of 1 are convenient for such usage.

5.7.3.3 NULL Word

Since this device is a DMP device, the NUL markers (two NUL bytes on a word boundary) that can mark the end of useful information in the buffer are not interpreted by the WRITE command. However, since this marker is written on disc, a READ operation causes it to again appear in the READ buffer as data, allowing any syntax analysis routines which depend on it to find it in the normal place at the end of useful information.

If a sector was originally written with a WEOF operation, the EOF event bit in the programmer's UFT is set when the sector is read. The programmer's buffer also has the ASCII value '$$' stored in bytes 0 and 1 and two NUL bytes stored in bytes 2 and 3.

5.7.4 WRITE TO DISC PARTITION

The WRITE operation causes one sector to be written to the disc. Since there is the possibility of losing data in track mode, all writes are done in record mode. If the size of the programmer's buffer is equal to or less than the partition's sector size in words (even number of bytes), the exact number of words specified is transmitted and the remainder, if any, of the sector is zero filled. If the buffer is larger than a sector, only a sector is written and the remainder of the data in the programmer's buffer is ignored.

If the partition has been specified to have an unlimited record size, a buffer size of up to 16,384 words (limit of one DMP transfer) can be specified with one WRITE operation. An EOR mark is automatically written in the last sector that falls within the write range if this feature has been SYSGENed for the partition (see DISCDEVICE SYSGEN statement) or optioned in the UFT (Bit 7 of extended UFT Option Word, XUFOPT). This flag causes a multi-sector READ operation to terminate short of its specified buffer size if this sector is encountered before the specified block size is satisfied.

The sector (starting sector for unlimited record size partition) to be accessed during the WRITE operation is determined in exactly the same manner as in the READ operation.

5.7.5 REWIND AND HOME TO DISC PARTITION

The REWIND and HOME operations do not transmit any data to the disc, but the disc partition must not be offline when the operations are specified. The HOME operation is a null operation. The REWIND operation resets the FPI to zero in the programmer's UFT and in the File Assign List entry. HOME and REWIND cause the EOF and BOM event bits to be set in the UFT status word.

One of these operations is appropriate at the beginning of a program when device-independent conventions are being followed by the programmer. HOME must be used instead of REWIND when the position of the FPI (next addressable sector) is not to be changed.

5.7.6 BACKSPACE RECORD TO DISC PARTITION

The BACKSPACE RECORD operation subtracts one from the File Position Index (in UFT and FAT if sequential, in UFT if RANDOM) and then reads the indicated logical sector. The physical sector is computed by the same algorithm used for the READ operations. A two-word buffer built into the handler is used for this operation so that the programmer does not have to set aside a buffer. When the READ operation is complete, the FPI is set to the sector just read, so that this is the next sector accessed on the next forward operation.

If the accessed sector was a file-mark record ($$), the EOF bit is set in the programmer's UFT. BACKSPACING a disc sequentially is often convenient when device-independence is the programmer's goal. If BACKSPACING beyond sector Ø is attempted, no operation (null) occurs and the EOF and BOM bits are set in the UFT.

5.7.7 BACKSPACE FILE TO DISC PARTITION

The BACKSPACE FILE operation is similar to BACKSPACE RECORD except that the process continues until a file-mark record or beginning-of-media (sector Ø) is found. The appropriate event bits are set in the programmer's UFT. The operation node is dequeued at the end of each disc record and then requeued so that higher priority operations on the disc controller can take precedence over its completion.

5.7.8 ADVANCE RECORD TO DISC PARTITION

The ADVANCE RECORD operation is similar to BACKSPACE RECORD except that the FPI is incremented in a forward direction. The operation is as fast as a READ operation, and it sets the EOF event bit in the programmer's UFT if a file-mark record is encountered. If the last sector of the partition is encountered, the EOM event bit is also set.

5.7.9 ADVANCE FILE TO DISC PARTITION

The ADVANCE FILE operation is similar to BACKSPACE RECORD except that the FPI is incremented in a forward direction. This operation continues until a file-mark record or end-of-media (last sector of partition) is detected. The appropriate bits are set in the programmer's UFT. The operation node is dequeued at the end of each disc record and then requeued so that higher priority operations on the disc controller can take precedence over its completion.

5.7.10 WEOF TO DISC PARTITION

The WEOF operation causes the addressed sector, as specified by the current FPI, to be written with the EOF hardware flag set in the sector. A two-byte buffer containing the bytes '$$' is written and the remainder of the sector is zero filled. The FPI is incremented by one and the EOF event bit is set in the UFT word UFTSTA. If the last sector of a partition is written, the EOM event bit is set.

5.7.11 SUMMARY TABLES

Large Capacity Moving-Head Disc Handler summary tables appear at the end of this chapter. Table 5-2 contains information about the handler's response to I/O operations in the four modes of data transfer. Table 5-3 lists the error and event bits in the UFT status word (UFTSTA). Conditions causing the error or event are also listed. Table 5-4 shows the secondary status word (UFTBCT).

5.8 DEVICE DEPENDENT FEATURES

The programmer can exert control over the extended features of the 4138 disc controller. This is accomplished by the device dependent option field of the UFT word XUFOPT. The device dependent options are specified in the right byte of UFT word XUFOPT. Figure 5-1 shows the extended UFT Option Word, XUFOPT.

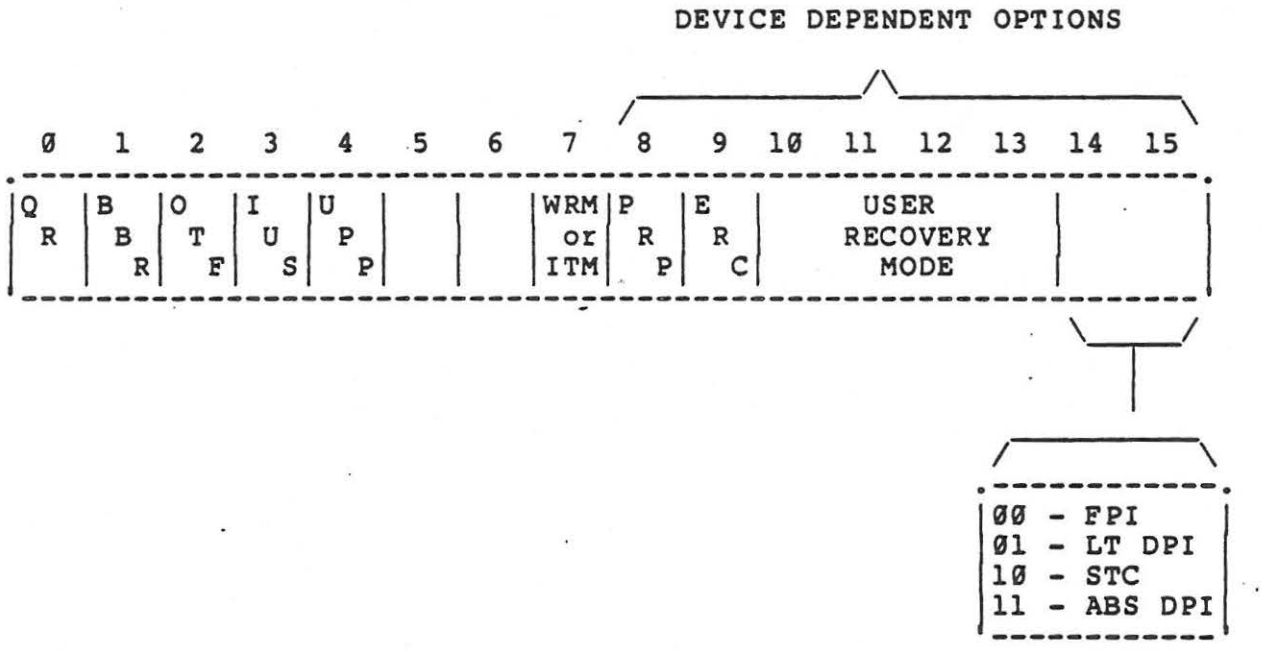

Figure 5-1. Extended UFT Option Word (XUFOPT)

5.8.1 WRITE RECORD MARK - BIT 7 - WRM

A WRITE operation to a partition does not cause an End-of-Record (EOR) mark to be added to the last sector of the record unless either the DISCDEVICE SYSGEN statement specifies its unconditional addition or this bit is set in the UFT word XUFOPT. Once an EOR mark has been written, a READ operation on that record cannot progress beyond the sector containing the EOR. These marks are generally used only when a partition has an unlimited record size and the programmer wishes to use the EOR detection capability to delimit records. To indicate detection of an EOR on a READ, the BOM event bit in the UFT status word is set.

5.8.2 INHIBIT TRACK MODE - BIT 7 - ITM

This bit (when set on a READ operation) causes the normal use of "track mode" to be eliminated. This may be desirable in reads which cause more than one track to be read in a single operation.

5.8.3 PREP - BIT 8 - PRP

This bit causes any WRITE operation to be performed in the Prep mode. This is used by special processors to initialize the disc packs to be used in the system. This is available to the programmer as a means to perform custom preparation operations or recovering lost prep in a realtime environment. The hardware requires that prep mode writes must be done in record mode, so Bits 12-13 are ignored.

5.8.4 ERROR CORRECTION MODE - BIT 9 - ERC

This bit enables the user recovery mode specified by Bits 10-13. User recovery mode causes a single method to be used (once only) instead of the normal multiple try of each of the methods. Thus a user may specify the type of recovery deemed appropriate when an error is detected.

The field of Bits 10 through 13 is used when ERC is on. It specifies which method is to be used during the user recovery operation. The valid codes are:

'0000 - Seek home, then normal try
'0001 - Normal Try
'0010 - Advance RST*
'0011 - Retard RST
'0100 - Move head offset forward
'0101 - Move head offset reverse
'0110 - Head offset forward and advance RST
'0111 - Head offset forward and retard RST
'1000 - Head offset reverse and advance RST
'1001 - Head offset reverse and retard RST
'1010 - Invoke ECC correction
'1011 - Reset device fault, then normal try
'1100 - Unassigned-normal try

'1101 - Unassigned-normal try
'1110 - Unassigned-normal try
'1111 - Unassigned-normal try

* RST = Read strobe timing

Functions 0010 to 1010 are illegal for WRITE operations.

Functions 1100 to 1111 are illegal for all operations.

Functions 0000 and 1011 cause the specified action to be followed by normal (mode 0001) operations so that the necessary READ/WRITE transfers occur.

If ERC bit is OFF (reset) then Bits 10 through 13 must also be reset ('0000).

5.8.5 ADDRESSING MODES - BITS 14-15

For privileged tasks, addressing modes other than the usual File Position Index (FPI) mode are avialable. These alternate addressing modes include:

- Logical Transport Device Position Index - LT DPI
- Sector/Track/Cylinder - STC
- Absolute Transport Device Position Index - ABS DPI

Figure 5-1 shows how these addressing modes are encoded.

Device Position Index (LT DPI) is a mode similar to the FPI except that it specifies a position relative to the start of the logical transport rather than relative to the start of a file.

Sector/Track/Cylinder (STC) modes is similar to ABS DPI except that it requires the use of a double word index and specifies the absolute sector and track in each half of the first word and the absolute cylinder in the second word.

Absolute Transport Device Position Index (ABS DPI) specifies an absolute position relative to the start of the physical transport.

NOTE: The concept of geometry and partition size are not meaningful for these alternate addressing modes.

5.9 ERROR RECOVERY

Four modes of error recovery are available to the user. The mode is selected by SR and RNQ in the UFT option word as follows:

SR	RNQ	
Ø	Ø	Local recovery, without retries.
Ø	1	Local recovery, return after retries are attempted.
1	Ø	System recovery, place device offline after failure.
1	1	System recovery, as above except return if the operation cannot be queued.

If either bit is set, the retry sequences explained in the following paragraphs will be attempted so long as ERC mode is not used. When ERC mode is used the handler makes no retry attempts--it is expected that the user will specify the appropriate method to use to recover from any errors encountered.

If the user cannot tolerate having a file go "offline", the '01 (above) specification should be used. If a seek error occurs during READ or WRITE, a SEEK home is issued before any further error recovery is attempted.

5.9.1 READ ERRORS

While in Record mode, this device has the capability to change the head position or the read timing for the purpose of error recovery, both of which are used by the handler. For this reason, all read error recovery is done in record mode. Additionally, Error Correction Code (ECC) correction is provided and supported. If the handler detects a read error and the user has requested it to attempt recovery, the following sequence occurs: (NOTE: Each of the following steps is performed 3 times.)

1. Normal retry.
2. Advance read strobe timing.
3. Retard read strobe timing.
4. Move head offset forward. (Toward center of disc.)
5. Move head offset reverse. (Away from center of disc.)
6. Move head offset forward and advance read strobe timing.
7. Move head offset forward and retard read strobe timing.
8. Move head offset reverse and advance read strobe timing.
9. Move head offset reverse and retard read strobe timing.
10. Do ECC correction on the data with otherwise normal retry conditions.

If on any retry the operation is successful, the remaining sequence is skipped and control is returned to the user. If the entire sequence is unsuccessful and the user did not specify local recovery, the device is put offline.

Note that the 4138 Controller performs automatic head incrementation and read ahead. This will result in an error if the controller attempts to read past the last sector on the disc. This error can occur if no event bits are set in the postamble of the last sector (EOF, EOR). This problem may be avoided by either setting an event bit in the last sector (EOF, EOR), or by not including the last track of the media in the partitions defined by the SYSGEN.

5.9.2 AUTOMATIC ERROR RECOVERY

If the program addresses the disc using a file with Bit Ø (System Recovery) of the UFT option word set, automatic error recovery procedures are requested. The operation is retried if the following errors occur:

- Late termination
- Checksum error (parity)
- DMP memory parity
- DMP failure to transmit the numbers of words it was told to transmit
- Seek Error

NOTE: There is a condition where the number of words transmitted does not equal the specified amount because an EOR signal was detected on an unlimited record size partition. This is not an error condition and is not reported as one. However, the total number of bytes transferred is updated in the UFT, Word 4.

If the operation is still not successful after the retries, the handler puts the disc partition offline, thus causing the system to inform the operator of the unrecoverable condition. The disc partition stays offline with all subsequent operations being diverted to the partition's "slough" queue until the operator makes a decision. This decision may be:

- To try again (up to eight more times for writes or 3Ø times for reads)
- To let the program proceed as if the operation were successful, or
- To abort the task using that partition.

If one of the following errors occurs, the handler does not attempt any retries but immediately informs the operator (if Bit Ø of UFT option word is set).

- o Device inoperable (for example, power off)
- o Device media failure (scarred track)
- o Watchdog timer expires approximately 6 tenths of a second after last operation initiated (optional).

NOTE: When a device inoperable error occurs, secondary status is returned in UFTBCT (Word 4) of the UFT. (See Table 5-3 for an explanation of the secondary status bits).

A message reporting a holdup condition is output to the operator in the following format:

```
!xxx?/tttttt/oooooo
```

xxx - is the name of the disc partition

tttttt - is the calling task's name

oooooo - is the current task overlay name

This message reports the following conditions:

- o Device does not exist
- o Device under exclusive use by another task
- o Device already offline

5.9.3 USER ERROR RECOVERY

If the programmer did not set Bit Ø of the UFT option word, no error recovery is attempted but the programmer is immediately informed of the error condition by appropriate error bits being set in the UFT. The programmer must institute retry or device substitution operations, in a manner appropriate to the application.

5.9.4 LOK ABORT

If a write operation is attempted to a sector that is in the range of the enabled write-protect system, it is treated as a programmer error rather than a device error and the calling task is aborted with a reason code LOK.

5.9.5 EVENT LOGGING

The System Event Logging routines are called whenever disc problems are encountered and resolved by the handler. This is done so that degradation of system performance caused by disc problems does not go by unnoticed. Problems that are not resolved by the handler are reported and logged by other system routines.

On completion of an unsuccessful operation, the handler fetches and saves primary and extended status. It then updates a retry counter and either gives up if the counter is exhausted or retries the operation perhaps in some error recovery mode. On completion of a successful operation, the retry counter is checked, and if retries are indicated, the event logging routines are called. Various parameters are passed to these routines including one comprised of bits from the saved error status. The Device Dependent word is comprised of bits from the saved secondary status. The format of the Device Dependent word is described below.

Ø	Combined error pointer - copy of bit Ø of primary status word
1	Device fault
2	Drive is powered off or lacking a logic plug or busy on the other port
3	Two or more drives responding to the same unit address
4	Drive inoperability caused abortion of a covert write
5	Ø = other port has selection
6	Select issued for an illegal sector
7	Select issued for an illegal head
8	Controller is in diagnostic mode
9	Data transfer caused a head increment
1Ø	Ø
11	Selected unit stopped a scan which had been commanded to try for selection
12	Selected drive is not the same physical unit which last responded to this unit address or that the selected drive has been cycled down and is now ready again
13	Other port in dual port environment wants the drive
14	Unit select bit - copy of primary status bit
15	Unit select bit - copy of primary status bit

A detailed description of the I/O retry node format is contained in the EVENT LOGGING chapter of the MAX IV GENERAL OPERATING SYSTEM, System Guide Manual.

5.10 SYSTEM GENERATION

The following statements are required in a system generation source file if the 4138 disc is to be included in a system. Detailed descriptions of these statements and the rules of order are included in the MAX IV SYSGEN, System Guide Manual.

```
CONTROLLER      LDn,3,3,TIMED (MODEL 4138)
      .
      .
      .
FMTRANSPORT     PH0,0,LDn,,,,,,,[drive type]
                (see Table 5-1)

FMTRANSPORT     PH1,1,LDn,,,,,,,[drive type]
      .
      .
LOGTRAN         H0,PH0,...
LOGTRAN         H1,PH1,...
      .
      .
DISCDEVICE      name,H0,...other parameters
      .
      .
      .
```

NOTE: The dual port DCO is detected at COLD-START time and does not require any system generation statements to detect its presence.

TYPE	SECTORS/ TRACK	HEADS	CYLINDERS	TOTAL TRACKS	UNFORMATTED CAPACITY
1	42	19	411	7809	100MB
2	42	19	815	15485	200MB
3	64	19	411	7809	150MB
4	64	19	815	15485	300MB
5	64	19	823	15637	300MB
9	64	5	411	2055	40MB
10+	64	5	823	4115	80MB
11*	64	10	823	8230	160MB
12*	64	2	320	640	12MB
13*	64	4	320	1280	24MB

* Fixed Media Types.
\+ Fixed or Removable Media Types.

Table 5-1. Large Capacity Moving-Head Disc Drive Types

RANDOM OR SEQUENTIAL ADDRESSING — RECORD SIZE ≤ 256 BYTES; SPECIAL *OR ≤ 32768 BYTES

	ASCII MODES		BINARY MODES	
	STANDARD	NON-STANDARD	STANDARD	NON-STANDARD
0 READ	INPUT ONE SECTOR (STOP TRANSMISSION IF USER'S BUFFER SMALLER) OR *INPUT ONE MULTISECTOR BLOCK.	<------SAME	<-----SAME	<-----SAME
1 WRITE	OUTPUT ONE SECTOR (STOP TRANSMISSION IF USER'S BUFFER SMALLER) OR *OUT-PUT ONE MULTISECTOR BUFFER.	<------SAME	<-----SAME	<-----SAME
2 REWIND	LOGICALLY REWIND PARTITION'S FILE TO SECTOR 0. +	<-----SAME	<-----SAME	<-----SAME
3 BKFILE	LOGICALLY BACKSPACE PARTITION'S FILE AND READ SECTORS TILL FILE MARK SECTOR OR SECTOR 0 FOUND.	<-----SAME	<-----SAME	<-----SAME
4 BKRECORD	LOGICALLY BACKSPACE PARTITION'S FILE AND READ TO SEE IF IT IS A FILE MARK SECTOR.	<-----SAME	<-----SAME	<-----SAME
5 AVRECORD	LOGICALLY ADVANCE PARTITION'S FILE AND READ TO SEE IF IT IS A FILE MARK SECTOR.	<-----SAME	<-----SAME	<-----SAME
6 AVFILE	LOGICALLY ADVANCE PARTITION'S FILE AND READ UNTIL FILE MARK SECTOR OR LAST SECTOR (EOM) DETECTED.	<-----SAME	<-----SAME	<-----SAME
7 WEOF	OUTPUT ONE RECORD WITH ($$NUL...) AND FILE MARK (EOF) STATUS BIT SET IN HARDWARE POSTAMBLE AMD UFT STATUS.	<-----SAME	<-----SAME	<-----SAME
8 HOME	null+	<-----SAME	<-----SAME	<-----SAME

* Special partition for large multisector records.
\+ This operation sets EOF and BOM event bits in UFT status word.

Table 5-2. Large Capacity Moving-Head Disc Operations and Modes

PROGRAMMER'S ERROR BIT IN UFTSTA	OPERATOR'S REASON CODE	REASON FOR ERROR IF SET
Ø	ER	SOME ERROR EXISTS
1	OVF LATE TERMINATE	DEVICE DID NOT RECEIVE TERMINATE FROM THE IOP WITHIN 25 MICROSECONDS AFTER LAST WORD OF SECTOR TRANSFERED
2	PAR PARITY OR DATA CHECK	DISC CHECKSUM ERROR ON READ - ERROR CONDITION WILL NOT BE REPORTED TILL AFTER 3Ø RETRIES IF SYSTEM RECOVERY IS SPECIFIED
3	INO INOPERABLE	-DEVICE DOES NOT EXIST -DEVICE INOPERABLE (SEE TABLE 5-4) -WATCHDOG TIMER HAS EXPIRED
4	MPE MEMORY PARITY OR IOP ERROR	-MEMORY PARITY ERROR DETECTED WHILE DMP WAS TRANSMITTING DATA TO/FROM MEMORY -INVALID BUFFER ARGUMENTS WERE SPECIFIED
5	LOK WRITE LOCK	WRITE ATTEMPTED TO TRACK COVERED BY A WRITE PROTECT SWITCH (THIS ERROR ABORTS TASK IF SYSTEM RECOVERY SPECIFIED)
6	CIG CHARACTER IN GAP/SEEK ERROR	-ONE OR MORE SECTORS HAVE LOST THE PREAMBLE (PREP) INFORMATION. THIS CONDITION IS NOT REPORTED TILL AFTER RETRIES IF SYSTEM RECOVERY SPECIFIED -SEEK ERROR- THIS CONDITION IS NOT REPORTED TILL AFTER RETRIES IF SYSTEM RECOVERY SPECIFIED
7	OTH OTHER	-NONE-
8	HOL HOLD	DMP FAILED TO TRANSMIT NUMBER OF WORDS IT WAS TOLD TO TRANSMIT (WHEN THE NUMBER OF WORDS TRANSMITTED DOES NOT EQUAL SPECIFIED AMOUNT REQUESTED ON A LIMITED DISC PARTITION).
PROGRAMMER'S EVENT BIT IN UFTSTA	**REASON CODE**	**REASON FOR EVENT IF SET**
9	EOM END-OF-MEDIUM	SET WHEN LAST SECTOR OF PARTITION IS ACCESSED.
1Ø	EOF END-OF FILE	-SET AFTER WEOF, REWIND, OR HOME OPERATION. -SET WHEN A FILE-MARK SECTOR IS ACCESSED BY READ, ADVANCE, OR BACKSPACE OPERATION. -SET WHEN BACKSPACE OPERATION IS ATTEMPTED WHILE CURRENTLY POSITIONED AT THE BEGINNING OF A DISC PARTITION.
11	BOM BEGINNING-OF-MEDIUM	-SET AFTER REWIND OR HOME OPERATION. -SET WHEN BACKSPACE FILE OR RECORD BACKSPACES TO THE BEGINNING OF THE DISC PARTITION. -SET WHEN A READ OPERATION DETECTS AN END-OF-RECORD MARKER.

Table 5-3. Large Capacity Moving-Head Disc Errors and Events

PROGRAMMER'S ERROR/STATE BIT IN UFT WORD UFTBCT	REASON FOR ERROR	CORRECTIVE ACTION
1	DEVICE FAULT	MANUALLY CYCLE DRIVE DOWN AND BACK UP
2	NOT SELECTED	VERIFY CORRECT LOGIC PLUG IS PRESENT AND THAT OTHER PORT DOES NOT HAVE SELECTION
3	MULTIPLE SELECTION	CHECK LOGIC PLUGS FOR DUPLICATION
4	COVERT WRITE FAILED	PROBABLE HARDWARE FAILURE
5	OTHER PORT HAS SELECTION	INFORMATIVE STATUS ONLY
6	SECTOR NOT FOUND	CHECK SYSGEN PARAMETERS FOR THIS DEVICE
7	HEAD NOT FOUND	CHECK SYSGEN PARAMETERS FOR THIS DEVICE
8	CONTROLLER IN DIAGNOSTIC MODE	PROBABLE HARDWARE FAILURE
9	HEAD MOVEMENT OCCURRED	INFORMATION STATUS ONLY
10	DUAL PORT DCO INSTALLED	INFORMATION STATUS ONLY
11	SELECTION ACKNOWLEDGE	INFORMATION STATUS ONLY
12	PACK CHANGED	CHECK FOR CORRECT PACK MOUNTED AND RETRY OPERATION
13	DESELECTION REQUEST RECEIVED	INFORMATIVE STATUS ONLY
14 & 15	UNIT NUMBER OF DRIVE	INFORMATION STATUS ONLY

Table 5-4. Secondary Status (UFTBCT)

CHAPTER 6
MAX IV BULK MEMORY HANDLER (BMn)

The Bulk Memory Handler (BMHAN) is the Software Interface between the MAX IV Operating System user and the Bulk Memory System. The Bulk Memory System consists of the Bulk Memory Controller (BMC) and its Bulk Memory Device (BMD) and is essentially a fixed-head disc system. The design of BMHAN, although utilizing the special characteristics of this BM system, maintains fixed-head disc compatibility. Thus, the BM system can be introduced as a replacement for fixed-head systems into an existing CLASSIC 78xy installation without requiring programming changes to already existing programs. Some changes are necessary in the SYSGEN CONTROLLER statement for inclusion of end-of-file processing.

The data flow of the BM system, when configured with the standard partitioning technique of the current MAX IV Operating System, is shown in Figure 6-1.

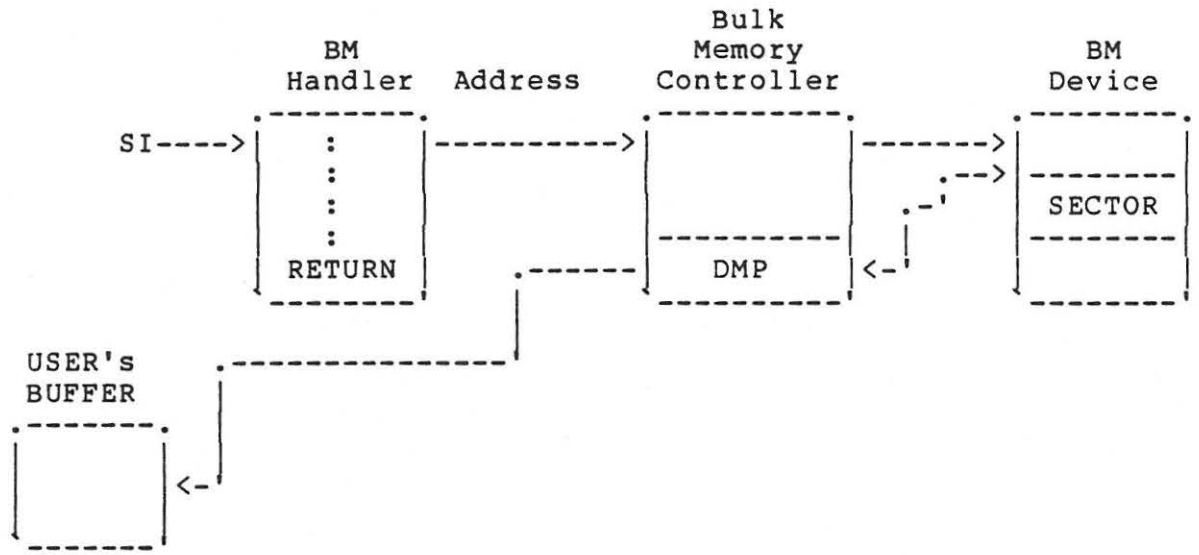

Figure 6-1. Bulk Memory System Data Flow

The BM handler consists of the TASK level and directly connected DATA and SERVICE interrupt routines. The DATA interrupt is used for Direct Memory Processor (DMP) END-OF-BLOCK detection. The DATA and SERVICE interrupts use unique hardware party-line interrupt vectors. These are permanent resident elements so that they are always available without delay. The elements are capable of controlling the transfer of data, status, and commands to/from a BM controller. The hardware controller and handler support up to four megabytes of core memory consisting of one to two Bulk Core files. Each Bulk Core file has one to eight 256K byte modules. Memory can be added in increments of 256K byte modules.

Additional controllers can be added if each has its own BM Device with separate data paths and queues. A single copy of the handler will serve all memory of all controllers if each controller is assigned its own unique group/unit number.

The standard controller names for system generation purposes and their standard device and DMP addresses are given in the description of the SYSGEN statements. A DMP is required for data transmissions directly to/from memory because of the very high data transfer rate. The data interrupt level is used as an end-of-block interrupt that occurs when the DMP finishes transmitting a block of data.

6.1 MEMORY PARTITIONS

Each Bulk Memory Device may be partitioned into many logical devices, each with its own independent addressing modes and error control. Most partitions can be made to simulate the sequential operation of a unit record magnetic tape when addressed by the programmer. However, these partitions can be addressed in a random access manner if the programmer chooses.

The naming conventions for Bulk Memory Device Logical Partitions are the same as those for disc partitions and are described in the MAX IV BASIC I/O SYSTEM, System Guide Manual.

Each memory partition has its own entry in the logical device list. Each partition also has its own unit record definition (words per sector or unlimited sector size). Partitions can even overlap the same memory space assigned to other partitions, giving the same memory area more than one set of rules which can be chosen by simply assigning the programmer's file to the appropriate partition.

6.2 HANDLER ADDRESSABILITY

The Bulk Memory Device Addressing Scheme is similar to the fixed head disc where there are 128 words per sector, 32 sectors per track and 32 tracks per module. The Bulk Core Module and head address form the "cylinder number". See Figure 6-2.

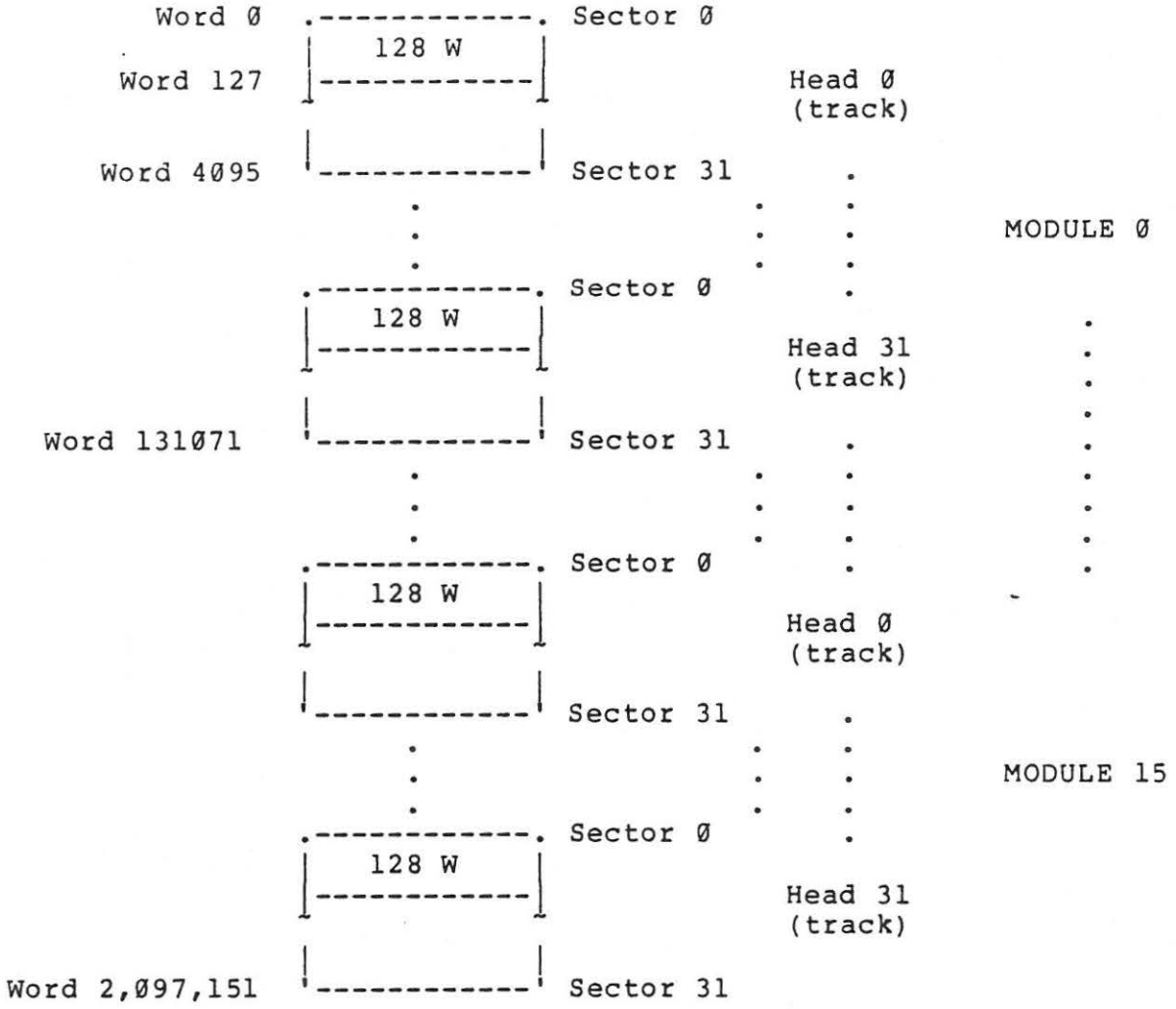

Figure 6-2. Bulk Memory Addressing Scheme

6.3 WRITE PROTECT

The Bulk Core Controller has nine hardware write protection switches that protect any contiguous number of tracks, starting from track Ø. This write lockout mechanism is usually used to protect system elements (for example, Libraries, macros).

Locked out tracks can also be accessed by the hardware FILL switch and a small area is usually reserved for fillable programs such as diagnostics, and stand-alone loaders.

To protect any number of tracks from writing, the eight 2-position lockout switches should be set to the binary number of the highest locked-out track. An additional 3-position switch enables the setting of the eight lockout switches when in the center position, permits writing to all tracks when in the bottom position and locks out writing to all tracks when in the top position.

6.4 DUAL PORT

The Bulk Memory device is capable of being accessed by two controllers, where each controller is connected to a different CPU I/O BUS. This dual port configuration is supported by the handler in a first-come-first-serve basis. In this configuration, it is possible, that one controller could keep the bulk memory device busy during a lengthy I/O operation, thereby locking out the other controller during that period of time. Normally, an 832 msec default timer incorporated in the controller hardware will watch for this condition. I/O operations in a dual-port environment, where both controllers are using the BM device, will be interleaved.

6.5 EOF BIT TABLE

At SYSGEN time, the controller statement has an option that when selected, will cause a reserved eight sectors of bulk memory called the EOF Bit Table to be established. When performing an ADVANCE, BACKSPACE or READ operation, the BM handler searches the table for an EOF condition, rather than reading the first four characters of each sector looking for ($,$,null,null). Thus, the BM handler can identify an EOF sector without using the data in the sector as the search criterion.

When programs write in the Non-Standard data mode to the bulk memory, it would be helpful to include the EOF Bit Table at SYSGEN. This eliminates the possibility of a Non-Standard data string being interpreted as an EOF mark. Refer to Figure 6-3.

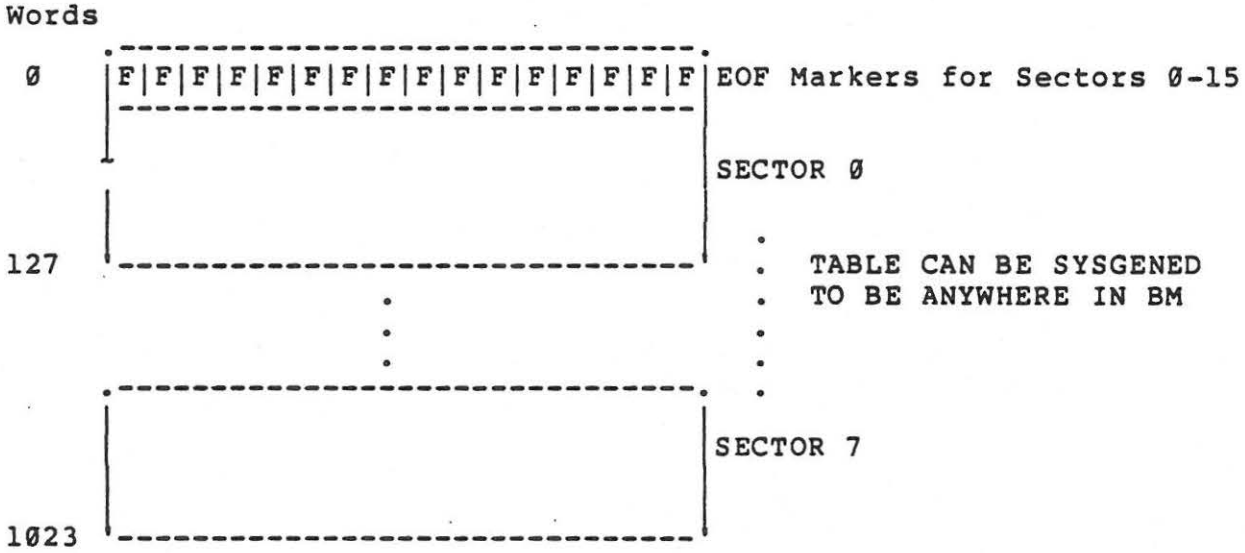

Figure 6-3. EOF Bit Table

6.6 I/O OPERATIONS

One operation at a time is completed by the controller before any attempt is made to examine other queued operations.

All four modes of operation, that is, Standard ASCII, Non-Standard ASCII, Standard Binary, and Non-Standard Binary, are identical to this handler.

6.6.1 FPI ABORT

Any READ, WRITE, WEOF, ADVANCE RECORD or ADVANCE FILE operation that attempts to access a sector beyond the end of the partition causes the calling task to be aborted with a reason code of FPI and a WHAT code of the logical file name.

6.6.2 EOM

Any READ, WRITE, WEOF, ADVANCE RECORD or ADVANCE FILE operation to the last sector of a partition causes the EOM event bit to be set.

6.6.3 READ FROM BULK MEMORY

The READ operation causes one sector to be read into the programmer's buffer. If the size of the buffer specified by the programmer is equal to or smaller than a sector, the transfer is terminated at the specified word count (even number of bytes). If the size of the buffer is larger than a sector, only a sector is transmitted. If the program is written in a device-independent manner, the programmer can call the I/O INFORMATION service to find the sector size and adjust his program logic accordingly.

6.6.3.1 Unlimited Record Size

If the partition has been specified to have an unlimited record size, a buffer size of up to 16,384 words (limit of one DMP transfer) can be specified with one READ operation. However, if the last word of memory is encountered, and the requested byte count is not yet satisfied, the operation will terminate with a "non-existent word address" error set in the UFT status word (Inoperable Bit 3 INO).

6.6.3.2 File Position Index FPI

The sector (STARTING sector for unlimited record size partitions) that is accessed during a READ operation is determined by the RANDOM flag, bit 5 in the UFT option word (UFTOPT). If this bit is reset, a sequential access method is assumed and the current File Position Index (FPI) that is maintained in the File Assign Table is used as the relative sector number. This number is converted by the handler to a hardware sector number, or device position index in the task level portion of the handler. When the READ operation is successfully completed the FPI value is incremented so that the next operation to this file will be to the next logical sector.

This incremented value is then moved to the programmer's UFT. If the RANDOM flag is set, a random access method is assumed and the FPI in the programmer's UFT is used directly as the desired logical sector number. Again, this is converted to the actual physical sector by the handler. When the READ operation is successfully completed, the FPI in the UFT is incremented. The File Assign Table FPI is not modified for RANDOM operations.

It can be easily seen that if the programmer never modifies the FPI in the UFT after he/she initially sets it, sequential operation occurs thereafter by default even in the RANDOM access mode until he/she modifies the FPI in the UFT. It should also be obvious that, since addressing of a partition is maintained at the UFT or file level, the programmer may keep many unique sequential pointers within the same memory partition by assigning the partition to a different file name for each independent index desired.

For partitions with unlimited sector size, the sequential index system is useless, particularly in a sequential mode, because it always points to the next logical sector. When such partitions are being used with records larger than a sector, the next sequential record may be accessed by the programmer manually incrementing the User File Table's FPI by an amount equal to the number of hardware sectors contained in each record.

6.6.3.3 NULL Word

Since this device is a DMP device, the NUL markers (two NUL bytes on a word boundary) that can mark the end of useful information in the buffer are not interpreted by the WRITE command. However, since this marker is written in memory, a READ operation causes it to again appear in the READ buffer as data, allowing any syntax analysis routines that depend on it to find it in the normal place at the end of useful information.

If a sector was originally written with a WEOF operation, subsequent reads of the sector will cause the EOF bit in the programmers UFT status word to be set. Also, the first four bytes of the programmers buffer will contain $,$,NULL,NULL.

6.6.4 WRITE TO BULK MEMORY

The WRITE operation causes one sector to be written to bulk memory. If the size of the programmer's buffer is equal to or less than the partition's sector size in words (128), the exact number of words specified is transmitted and the remainder of the sector is filled with zeros. If the buffer is larger than a sector, only a sector is written, and the remainder of the data in the programmer's buffer is ignored.

If the partition has been specified to have an unlimited record size, a buffer size of 16,384 words maximum (limit of one DMP transfer) can be specified with one WRITE operation.

The sector (starting sector for unlimited record size partition) to be accessed during the WRITE operation is determined in exactly the same manner as in the READ operation.

6.6.5 REWIND AND HOME TO BULK MEMORY

The REWIND and HOME operations do not transmit any data to memory, but the memory partition must be operable and not offline when the operations are specified. The HOME operation is a null operation. The REWIND operation resets the File Position Index to zero in the programmer's UFT and in the file assign list entry. Both operations set the EOF and BOM event bits in the UFT status word.

One of these operations is appropriate at the beginning of a program when device-independent conventions are being followed by the programmer. HOME must be used instead of REWIND when the position of the FPI (next addressable sector) is not to be changed.

6.6.6 BACKSPACE RECORD TO BULK MEMORY

The BACKSPACE RECORD operation subtracts one from the File Position Index (in the FAT and UFT if sequential, in the UFT if RANDOM).

If the EOF Bit Table was selected at SYSGEN time, the EOF bit corresponding to the FPI-1 is tested in the table. If set, the EOF bit in the programmer's UFT is set.

If the EOF Bit Table was not SYSGENed, a two-word buffer built into the handler is used during the READ operation so that the programmer does not have to set aside a buffer. When the READ operation is complete, the FPI is set to the sector just read, so that this is the next sector accessed on the next forward operation. If the accessed sector was a file-mark record ($,$,NUL,NUL), then the EOF bit is set in the programmers UFT.

If BACKSPACING beyond sector Ø is attempted, no operation (null) occurs and the EOF and BOM are set in the UFT.

6.6.7 BACKSPACE FILE TO BULK MEMORY

The BACKSPACE FILE operation is similar to BACKSPACE RECORD. If the EOF Bit Table was SYSGENed, the entire operation is performed by traversing the EOF Table, without dequeuing after each iteration.

If the EOF Bit Table was not SYSGENed, the READ process continues until a file-mark record or beginning-of-media (sector Ø) is found. The operation node is dequeued at end of each record read and then requeued so that higher priority operations on the bulk controller can take precedence over its completion.

6.6.8 ADVANCE RECORD TO BULK MEMORY

The ADVANCE RECORD operation is similar to BACKSPACE RECORD except that the File Position Index is incremented in a forward direction. The operation is as fast as a READ operation, and it sets the EOF event bit in the programmer's UFT if a file-mark record is encountered. If the last sector of the partition is encountered, the EOM event bit is also set.

6.6.9 ADVANCE FILE TO BULK MEMORY

The ADVANCE FILE operation is similar to BACKSPACE FILE except that the File Position Index is incremented in a forward direction. This operation continues until a file-mark record or end-of-media (last sector of partition) is detected. The appropriate bits are set in the programmer's UFT.

6.6.10 WEOF TO BULK MEMORY

The WEOF operation causes the next sector, as specified by the current File Position Index, to be written with a 4-byte buffer containing the bytes $,$,NUL,NUL, and the remainder of the sector is zeroed. The FPI is incremented by one at the successful completion of the operation. The operation is similar to the WRITE except for the data transmitted. If the EOF Bit Table was SYSGENed, the appropriate EOF bit in the table is also set.

6.6.11 SUMMARY TABLES

Bulk Memory Handler summary tables appear at the end of this chapter. Table 6-1 contains information about the handler's response to I/O operations in the four modes of data transfer. Table 6-2 lists the error and event bits in the UFT status word (UFTSTA). Conditions causing the error or event are also listed.

6.7 ERROR RECOVERY

6.7.1 AUTOMATIC ERROR RECOVERY

If the programmer addresses a file on the BM device with the system recovery option set in the UFT, he/she is requesting automatic system error recovery procedures. The operation is retried up to eight times if the following errors occur:

- DMP memory parity
- DMP failure to transmit the number of words it was told to transmit

If the operation is still not successful after eight tries, the handler puts the logical device offline, thus causing the X TASK to inform the operator of the unrecoverable condition. The logical device stays offline with all subsequent operations being diverted to the logical devices "slough" queue until the operator makes a decision. This decision may be:

- To try again (up to eight more times),
- To let the program proceed as if the operation were successful, or
- To abort the task using that logical device.

If one of the following errors occurs, the handler does not attempt eight retries but immediately informs the operator (system recovery selected).

- Device inoperable (for example, power off)
- Timer expires approximately 8 seconds after last operation initiated (optional)

A message reporting a holdup condition is output to the operator in the following format:

```
!xxx?/tttttt/oooooo
```

xxx - is the name of the memory partition

tttttt - is the calling task's name

oooooo - is the current task overlay name

This message reports the following conditions:

- Device does not exist
- Device under exclusive use by another task
- Device already offline

6.7.2 USER ERROR RECOVERY

If the programmer did not select system recovery in the UFT, no error recovery is attempted but the programmer is immediately informed of the error condition by appropriate error bits being set in the UFT. The programmer must institute retry operations in a manner appropriate to the applications.

6.7.3 LOK ABORT

If a WRITE operation is attempted to a sector that is in the range of the enabled write-protect system, it is treated as a programmer error rather than a device error. If system recovery is specified, the calling task will be aborted with reason code equal to LOK.

6.8 SYSTEM GENERATION

The following statements are required in a system generation source file if the Bulk Memory Device is to be included in the system.

Detailed descriptions of these statements and their relative order in the SYSGEN sequence can be found in the MAX IV S¥SGEN, System Guide Manaul. These statements are the same as those for disc devices, except where explicitly defined below:

```
CONTROLLER      BMn,,,,,,,,[TABLE]
                           [#track address]
```

TABLE - When parameter 9 is specified as "TABLE", the EOF Bit Table will be included in the system. The table will be located directly behind the last file SYSGENed and cannot be accessed by the user.

#track address - When parameter 9 is specified as a track number, the EOF Bit Table will be included in the system and will start at the track number specified.

When parameter 9 is missing, the EOF Bit Table will not be included.

DISCCHAR

No additional parameters are specified for BM.

DISCDEVICE

No additional parameters are specified for BM.

FMTRANSPORT tname,tnum,BMn,,,,,,[#bulk memory modules]

bulk memory modules - Parameter 9 is optional and it specifies the number of bulk memory modules in the device (1 to 16, where each module contains 256K bytes memory).

When parameter 9 is missing, the DEFAULT value of 16 is assumed.

LOGTRAN

No additional parameters are specified for BM.

6.9 PROCEDURE FOR ALTERING MEMORY SIZE

The Bulk Memory Device size can be expanded or contracted in increments of 256K byte modules. Once a system is SYSGENed with Bulk Memory, memory modules cannot be added or deleted without losing all data on the BM device. This is due to the interleaved addressing characteristic of the BM hardware. In order to preserve the contents of the files on Bulk Memory during memory size alteration, the following procedure can be employed:

1. Copy contents of all existing BM files to an auxillary storage medium (disc, tape, et cetera).

2. RESYSGEN with the new BM device size specified in the FMTRANSPORT statement.

3. If BM had been under FILE MANAGER control, continue with step 4. If BM had been under BIOS control, go to step 6.

4. Perform the appropiate OC directive to switch the BM device from FILE MANAGER control to BIOS responsibility.

5. Execute the background prep processor to reinitialize the BM device under FILE MANAGER control (FMPREP function).

6. Copy all files previously stored on auxillary storage device onto the BM device.

	BULK MEMORY RANDOM OR SEQUENTIAL ADDRESSING ASCII MODES		RECORD SIZE ≤ 256 BYTES SPECIAL *(OR ≤ 32768 BYTES) BINARY MODES	
	STANDARD	NON-STANDARD	STANDARD	NON-STANDARD
Ø READ	INPUT ONE SECTOR (STOP TRANSMISSION IF USER'S BUFFER SMALLER) OR INPUT ACCORDING TO USER BYTE COUNT (ONE MULTI-SECTOR RECORD).	SAME <--------	SAME <---------	SAME <----------
1 WRITE	OUTPUT ONE SECTOR (STOP TRANSMISSION IF USER'S BUFFER SMALLER) OR OUTPUT ONE MULTISECTOR BLOCK.	SAME <--------	SAME <---------	SAME <----------
2 REWIND	SET FPI OF LOGICAL FILE TO ZERO.+	SAME <---------	SAME <---------	SAME <----------
3 BKFILE	EOF TABLE: SEARCH TABLE FOR EOF BIT UNTIL BOM. NO TABLE: READ SECTORS FOR FILE MARK UNTIL BOM.	SAME <----------	SAME <---------	SAME <----------
4 BKRECORD	LOGICALLY BACKSPACE FPI. EOF TABLE: CHECK EOF BIT. NO TABLE: READ 2 CHARACTERS, AND CHECK FOR FILE MARK.	SAME <----------	SAME <---------	SAME <----------
5 AVRECORD	LOGICALLY ADVANCE FPI. EOF TABLE: CHECK EOF BIT. NO TABLE: READ 2 CHARACTERS, AND CHECK FOR FILE MARK.	SAME <----------	SAME <---------	SAME <----------
6 AVFILE	EOF TABLE: SEARCH TABLE FOR EOF BIT UNTIL EOM. NO TABLE: READ SECTORS UNTIL FILE MARK OR EOM.	SAME <---------	SAME <---------	SAME <----------
7 WEOF	OUTPUT ONE SECTOR WITH "$,$,NUL,NUL". IF EOF TABLE THEN ALSO SET EOF BIT.	SAME <---------	SAME <---------	SAME <----------
8 HOME	NULL +	SAME <---------	SAME <---------	SAME <----------

* Special logical device for large multi-sector records.
\+ This operation sets EOF and BOM events in UFT status word.

Table 6-1. Bulk Memory Operations and Modes

PROGRAMMERS ERROR BIT IN UFTSTA	OPERATOR'S REASON CODE	REASON FOR ERROR IF SET
0	ER ERROR	ERROR, SEE OTHER BITS.
1	DTE DEFAULT TIMER ERROR	I/O OPERATION WAS INITIATED BUT NOT STARTED BY CONTROLLER BEFORE 0.834 SEC. REASONS: o OTHER CONTROLLER IN DUAL PORT CONFIGURATION IS HOLDING BM. o HARDWARE FAILURE.
2	PAR WORD PARITY	A WORD PARITY ERROR WAS DETECTED DURING A READ COMMAND IN BULK MEMORY.
3	INO INOPERABLE	-BM DEVICE DOES NOT EXIST. -BM DEVICE POWER OFF. -ATTEMPTED ACCESS BEYOND MEMORY PLANES CONFIGURED.
4	MPE	-MEMORY PARITY ERROR DETECTED WHILE DMP
5	LOK WRITE LOCKOUT	WRITE ATTEMPTED IN TRACK WHICH IS COVERED BY A WRITE PROTECT SWITCH.
6	FDE FORCE DESELECT ERROR	I/O WAS ABNORMALLY TERMINATED BY ANOTHER CONTROLLER IN A DUAL PORT CONFIGURATION.
7	OTH OTHER	-NONE-
8	ARL ACCESS RIGHTS OR LENGTH	-DURING DMP VIRTUAL MODE I/O, ACCESS RIGHTS ON A CHAIN OR DATA PAGE WHERE VIOLATED. -THE REQUESTED I/O BYTE LENGTH EXCEEDS THE SIZE OF THE MAP.
PROGRAMMER'S EVENT BIT IN UFTSTA	REASON CODE	REASON FOR EVENT IF SET
9	EOM END-OF-MEDIUM	SET WHEN LAST SECTOR OF PARTITION IS ACCESSED.
10	EOF END-OF-FILE	-SET AFTER WEOF, REWIND, OR NULL OPERATION. -IF EOF TABLE EXISTS, SET WHEN EOF BIT IS FOUND IN A READ, ADVANCE OR BACKSPACE OPERATION. -IF EOF TABLE DOES NOT EXIST, SET WHEN A FILE MARK SECTOR IS FOUND IN A READ, ADVANCE, OR BACKSPACE OPERATION.
11	BOM BEGINNING OF MEDIUM	UNRECOVERABLE PROGRAM ERROR DETECTED AT TASK LEVEL; CAUSES AN ABORT OF CALLING TASK WHEN SYSTEM RECOVERY IS SPECIFIED.

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Printed in the U.S.A.